# Chapter 4A: STA Performance and Compliance

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Working in conjunction with the best management practices of the Everglades Agricultural Area (EAA) discussed in the previous chapter, the STAs represent the second stage of a phosphorus control program for the northern Everglades. Four of the six STAs are fully operational and are removing phosphorus that otherwise would have gone into the Everglades Protection Area (EPA). During Water Year 2002 (WY02), STA-1W, STA-2, STA-5 and STA-6 Section 1 treated more than 826 cubic hectometers (670,244 acre feet) of water and removed more than 83 metric tons of phosphorus, for an overall 71 percent removal rate. Flows and phosphorus inflows to the STAs increased considerably from the drier conditions of the previous water year.

To date, the four operational STAs have reduced phosphorus concentrations to less than 35 parts per billion (ppb), well below the long-term design target of 50 ppb. Since the initiation of STA operation in 1994, the STAs have reduced phosphorus loads by approximately 198 tons through April 2002.

**Table 4A-1.** Summary of STA phosphorus removal

| STA | WY2002 Inflow TP (metric tons) | WY2002 TP Removal (metric tons) | Total to Date Inflow TP (metric tons) | Total To Date TP removal (metric tons) |
|---|---|---|---|---|
| **STA-1W** | 43.3 | 30.9 | 158 | 123 |
| **STA-2** | 20.5 | 15.6 | 20.5 | 15.6 |
| **STA-5** | 49.6 | 33.4 | 65.3 | 41.7 |
| **STA-6** | 4.6 | 4.1 | 21.2 | 17.4 |
| **Total** | 118 | 84.0 | 265 | 198 |

An overview of the STA operations, vegetation, phosphorus performance, water quality monitoring, and permit compliance is presented in this section for each of the STAs. Water quality parameters addressed include nutrients, dissolved oxygen, pesticides and mercury. This information is provided to document compliance with appropriate conditions of the Everglades Forever Act (EFA) and USEPA National Pollution Discharge Elimination System (NPDES) permits. Water quality monitoring within and downstream of the STAs demonstrated that the four STAs in operation are in full compliance with state operating permits. A summary of STA operations and

phosphorus removal is presented in **Table 4A-2**. Appendices provide additional details of the monitoring program required by state operating permits.

**Table 4A-2.** Summary of STA operations

| STA | Operational Status | Performance | Other Issues |
|---|---|---|---|
| **STA-1 East** | Under construction by Corps of Engineers<br><br>Scheduled for completion in 2003 | No performance data yet | None identified |
| **STA-1 West** | Fully operational; in stabilization phase; 292 cubic hm (237,000 acre-feet) treated in WY2002. | 30.9 metric tons of TP removed in WY2002; 71% load reduction; flow-weighted mean inflow TP concentration was 148 ppb; outflow concentration was 38 ppb | None identified |
| **STA-2** | Two of three cells are fully operational and are in stabilization phase. 267 cubic hm (216,185 acre-feet) treated in WY2002. | 15.6 metric tons of TP removed in WY2002; 76% load reduction; flow-weighted mean inflow TP concentration was 77 ppb; outflow concentration was 16 ppb | Monitoring elevated mercury in cell 1 |
| **STA-3/4** | Under construction; scheduled for completion 10/2003 | No performance data yet | 3 large contracts were taken over by a new company; reviewing recovery schedule. |
| **STA-5** | Fully operational; in stabilization phase; 202 cubic hm (164,000 acre-feet) treated in WY2002; diversion of 41.7 cubic hm required through G-406 | 33.4 metric tons of TP removed in WY2002; 67% load reduction; flow-weighted mean inflow TP concentration was 245 ppb; outflow concentration was 81 ppb | None identified |
| **STA-6** | Fully operational; in post-stabilization phase; 65.9 cubic hm (53,400 acre-feet) treated in WY2002. | 4 metric tons of TP removed in WY2002; 88% load reduction; flow-weighted mean inflow TP concentration was 70 ppb; outflow concentration was 16 ppb | None identified |

# STA-1 EAST UPDATE

The construction of STA-1 East is being managed by the U.S. Army Corps of Engineers (USACE). Construction on the inflow and outflow pump stations for STA-1 East commenced in May 2000 and September 2000, respectively, and are scheduled for completion in January 2003 and February 2003, respectively, according to the August 2002 Status Report to Judge Hoeveler. Construction of the interior works was initiated in January 2002 and is scheduled to be completed in phases. The eastern distribution cell and cells 1 and 2 may be complete as soon as March 2003; another flow path may be ready for internal start-up by October 2003, and all of the flow paths are scheduled to be complete by January 2004. To accelerate the startup period, the District and the USACE are currently discussing early hydration of treatment cells for vegetative establishment. A schematic of STA-1 East is presented in **Figure 4A-1**. Based on the 1979-88 period of flow and phosphorus data used during design, the STA should receive approximately 94,000 acre feet from the C-51 West basin and approximately 31,000 acre feet from the S-5A basin though the G-311 structure. Actual deliveries will vary based on hydrologic conditions in the basins.

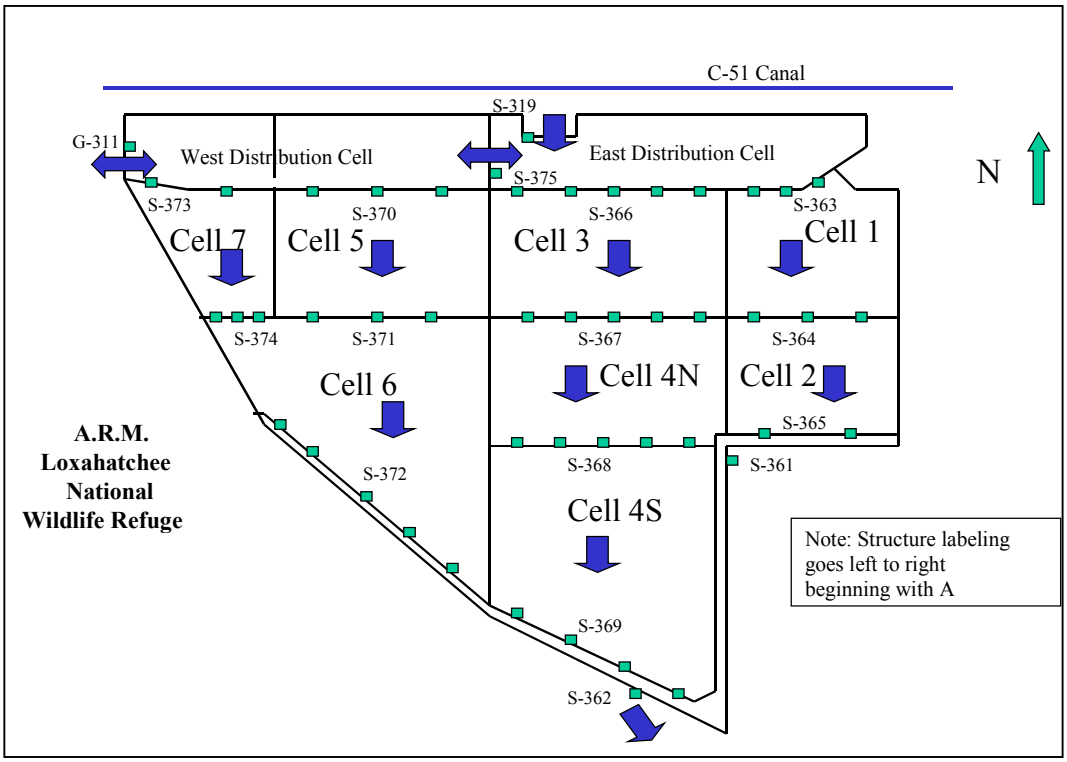



**Figure 4A-1.** Schematic of STA-1 East (not to scale)

# STA-1 WEST

STA-1W contains approximately 6,670 acres of effective treatment area arranged in three flow-ways. The eastern flow-way contains cells 1 and 3, with an effective treatment area of approximately 2,516 acres. The western flow-way contains cells 2 and 4, with an effective treatment area of approximately 1,300 acres. The northern flow-way (cell 5) consists of approximately 2,855 acres. In addition, STA-1W includes the STA-1 inflow basin, with inflow pump station S-5A, and four gated spillways that allow tremendous operational flexibility. Based on the 1979-88 period of flow and phosphorus data used during design, the STA should receive approximately 125,000 acre feet from the S-5A basin, approximately 11,500 acre feet from the C-51 West basin, approximately 4,300 acre feet from the East Beach Water Control District, approximately 2,300 acre feet of Lake Okeechobee regulatory releases, and BMP replacement water from the Lake. Actual deliveries will vary based on hydrologic conditions in the basins.

Inflows into STA-1W from the S-5A pump station were directed into STA-1W (cells 1 through 4) via the G-302 and G-303 structures and into the northern flow-way (cell 5) via the G-302 and G-304A-J structures (**Figure 4A-2**). Full flow-through operations through cells 1 through 4 have occurred since August 1994, when these cells were part of the old Everglades Nutrient Removal Project. Full flow-through operations through cell 5 have occurred since July 2000. Treated water from STA-1W has been discharged into the Arthur R. Marshall Loxahatchee National Wildlife Refuge (Refuge) via the G-251 and G-310 pump stations throughout WY02.

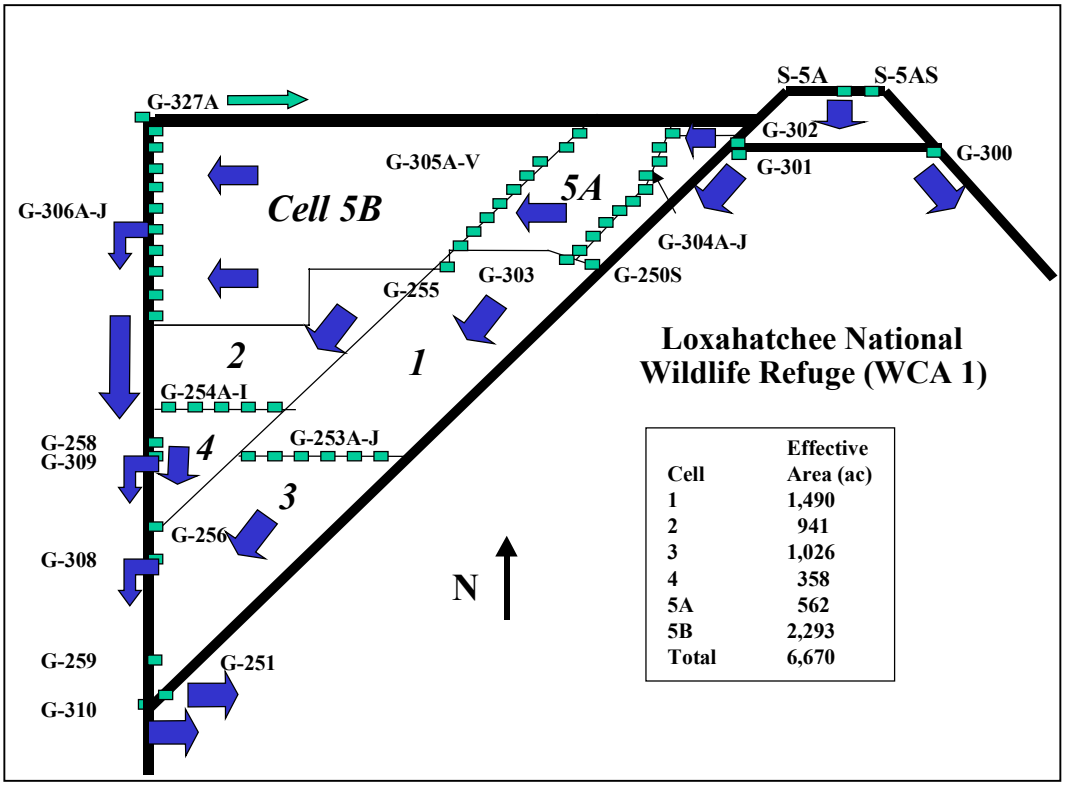
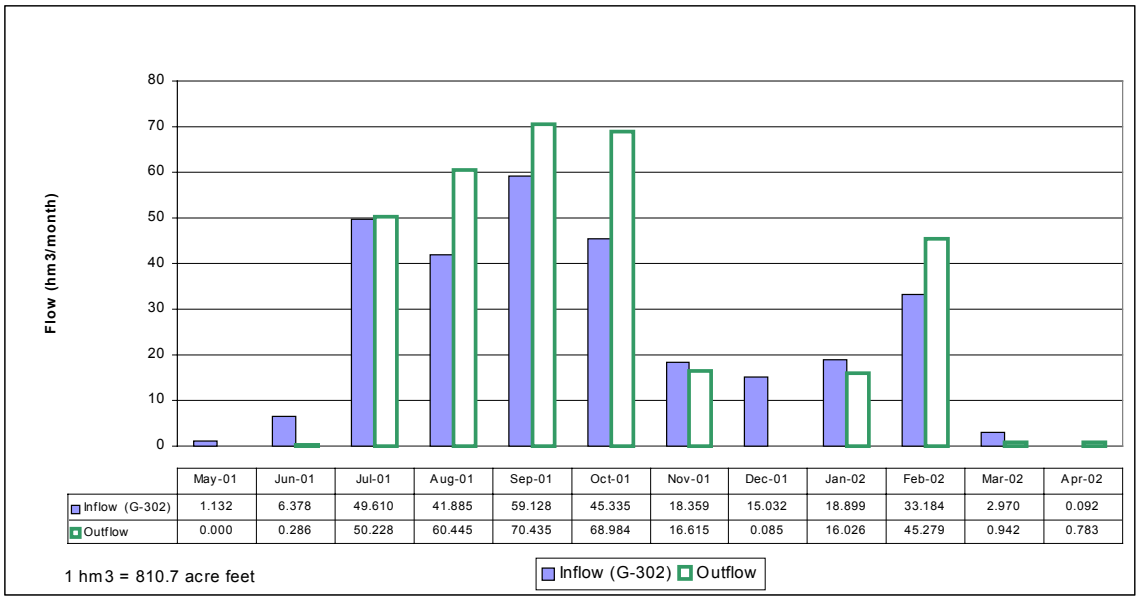



**Figure 4A-2.** Schematic of STA-1 West (not to scale)

## STA-1W OPERATIONS

In early WY02, operations at STA-1W were influenced by the latter stages of a severe drought in South Florida, but a typical rainfall cycle returned in June, 2001, and normal wet season operation of most project structures resumed. Supplemental water was not required at any time during WY02 to protect plant communities within STA-1W, and no adverse impacts to the plant communities were found. Discharge from STA-1W during the dry season closely followed significant rainfall events in the S-5A pump station basin of the EAA. Dry-season operations at STA-1W began in December 2001, when District water managers began operating the wetland in a water conservation mode as described in the STA-1W operation plan. In this mode, water is conserved in the wetland when deemed necessary to protect the plant communities and help maximize phosphorus removal performance upon returning to flow-through conditions. Dry-season operations at STA-1W continued through the end of the reporting period.

During WY02, discharge to the STA-1W treatment cells via G-302 was approximately 292 cubic hm (236,731 acre feet), equal to an average hydraulic loading rate of 3.0 cm/d over the effective treatment area of the STA. The annual volume of treated water discharged to the Refuge was 330 cubic hectometers (267,624 acre feet), or about 150 percent of the anticipated long-term average annual flow for the treatment area. The difference between the inflow and outflow volumes reflects the net contributions of direct rainfall, evapotranspiration (ET), seepage from the Refuge, seepage losses to the adjacent lands, and deep percolation. A summary of monthly flows is presented in **Figure 4A-3**.




| | May-01 | Jun-01 | Jul-01 | Aug-01 | Sep-01 | Oct-01 | Nov-01 | Dec-01 | Jan-02 | Feb-02 | Mar-02 | Apr-02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow (G-302) | 1.132 | 6.378 | 49.610 | 41.885 | 59.128 | 45.335 | 18.359 | 15.032 | 18.899 | 33.184 | 2.970 | 0.092 |
| Outflow | 0.000 | 0.286 | 50.228 | 60.445 | 70.435 | 68.984 | 16.615 | 0.085 | 16.026 | 45.279 | 0.942 | 0.783 |

**Figure 4A-3.** Summary of Water Year 2002 flows for STA-1W

## STA-1W VEGETATION

The composition of the plant communities in STA-1W varies among the five treatment cells in the project, but is generally dominated by either cattail (Typha sp.) or submerged aquatic

vegetation (SAV) and periphyton. Cell 1 is cattail-dominated but also has significant amounts of SAV and periphyton. Other notable plant species in cell 1 include Carolina willow (*Salix caroliniana*) and leather fern (*Acrostichum sp*.). Cell 2 is dominated by cattail but also supports a large coverage of SAV and periphyton. Cell 3 is dominated by cattail but still contains a mosaic of native wetland plant species planted during the construction of the ENR Project. Cell 4 is an SAV and periphyton cell by design, and any emergent plant species are subject to control methods using appropriate herbicides. Cell 5A is managed as an emergent marsh and is dominated by cattail, while cell 5B is an SAV and periphyton-dominated cell.

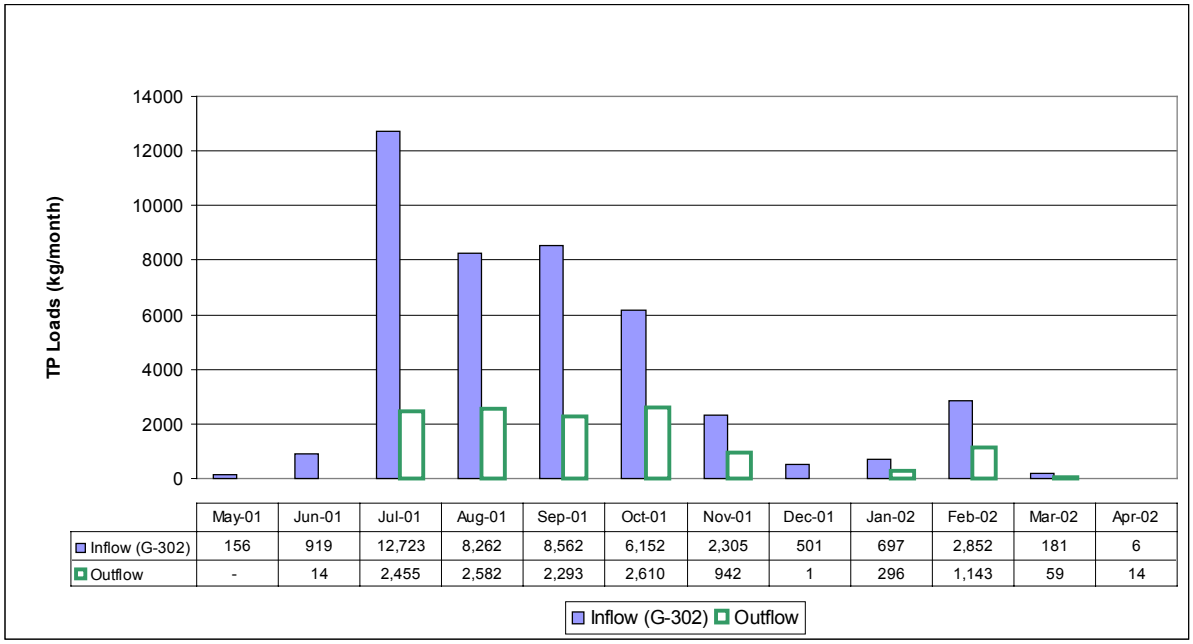
Specific condition 13(b) of the EFA permit requires that the annual *Everglades Consolidated Report* include information regarding the application of herbicides to exclude and/or eliminate undesirable vegetation within the treatment cells. For this reporting period, the District applied a total of 633 gallons of the Herbicide Rodeo, 28.5 gallons of Arsenal, and 79 gallons of various adjuvants (inert liquids used to help distribute the herbicide) to control various nuisance vegetation. Both aerial and ground-based spray equipment were used to apply these herbicides.

## STA-1 WEST WATER QUALITY MONITORING

The data presented in this section demonstrate that STA-1W was in compliance with the EFA and NPDES operating permits for this reporting period, and that discharges do not pose any known danger to public health, safety, or welfare. Specific Condition 14(C) of the EFA permit states that STA-1W will remain in the stabilization phase of operation until STA-1E and STA-2 begin flow-through operations. At this time, STA-2 has begun flow-through operations, but STA-1E is not expected to begin flow-through operations until 2003.

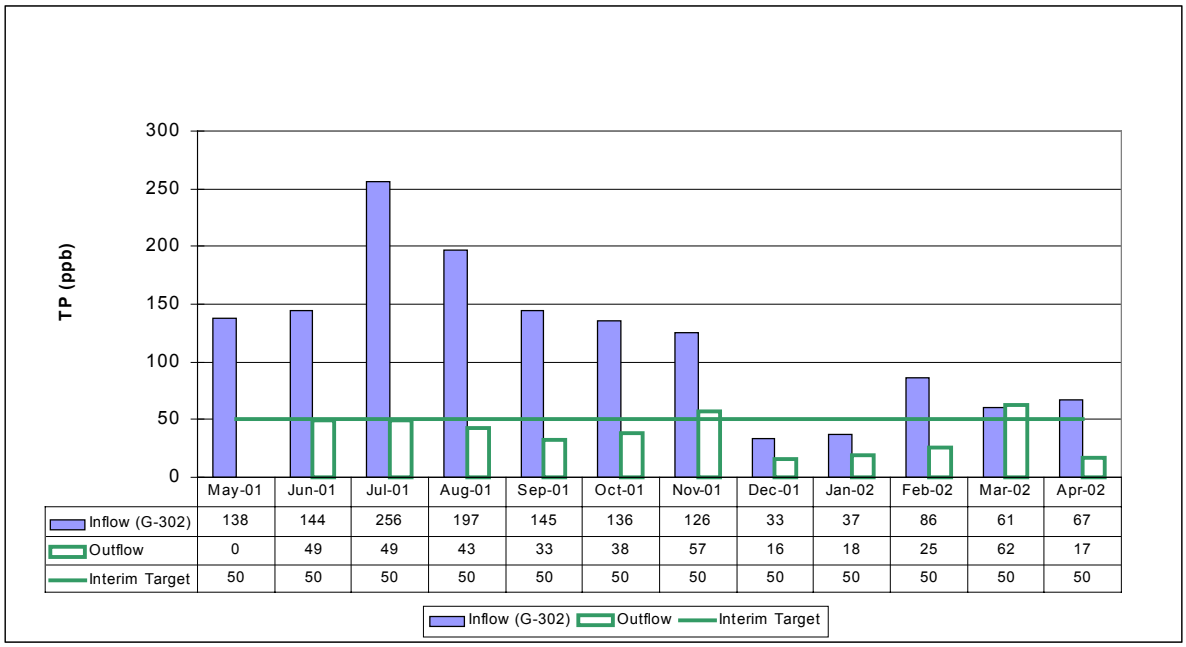
### Total Phosphorus

Under the design objectives of the Everglades Forever Act, STA-1W continues to achieve its interim discharge goal of less than 50 parts per billion for total phosphorus. During WY02 the STA received 43.3 metric tons of phosphorus, equal to a nutrient-loading rate of 1.60 grams/square meter. Approximately 30.9 metric tons of TP were removed by STA-1W during WY02. With the exception of March 2002, monthly discharge concentrations were considerably lower than inflow concentrations. For March 2002, the flow-weighted mean outflow concentration was 62 ppb, which was slightly higher than the inflow concentration of 61 ppb. However, the inflow volume was significantly higher (2,970 ac ft) than the outflow (942 ac ft) and hence the outflow load was actually lower (59 kg) than the inflow load (181 kg). Between May 2001 and April 2002 STA-1W reduced discharge loads of total phosphorus by 71 percent, compared to inflow loadings measured at G-302. A summary of monthly TP loads and flow-weighted mean TP concentrations are presented in **Figure 4A-4** and **4A-5**. The flow-weighted mean outflow concentration was 38 ppb, a 74-percent reduction from the inflow concentration of 148 ppb measured at G-302. For informational purposes the geometric mean phosphorus concentration of the discharge was 31 ppb. Permit compliance requires that outflow TP concentrations must also be reported as moving 12-month flow-weighted mean values. As shown in **Figure 4A-6**, TP values have been in compliance with permit conditions at the outflow pump stations for this entire reporting period. The moving 12-month flow-weighted mean TP outflow concentration for STA-1W ranged from 37 to 46 ppb.




| | May-01 | Jun-01 | Jul-01 | Aug-01 | Sep-01 | Oct-01 | Nov-01 | Dec-01 | Jan-02 | Feb-02 | Mar-02 | Apr-02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow (G-302) | 156 | 919 | 12,723 | 8,262 | 8,562 | 6,152 | 2,305 | 501 | 697 | 2,852 | 181 | 6 |
| Outflow | - | 14 | 2,455 | 2,582 | 2,293 | 2,610 | 942 | 1 | 296 | 1,143 | 59 | 14 |

**Figure 4A-4.** Summary of Water Year 2002 phosphorus loads for STA-1W




| | May-01 | Jun-01 | Jul-01 | Aug-01 | Sep-01 | Oct-01 | Nov-01 | Dec-01 | Jan-02 | Feb-02 | Mar-02 | Apr-02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow (G-302) | 138 | 144 | 256 | 197 | 145 | 136 | 126 | 33 | 37 | 86 | 61 | 67 |
| Outflow | 0 | 49 | 49 | 43 | 33 | 38 | 57 | 16 | 18 | 25 | 62 | 17 |
| Interim Target | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |

**Figure 4A-5.** Summary of Water Year 2002 phosphorus concentrations for STA-1W

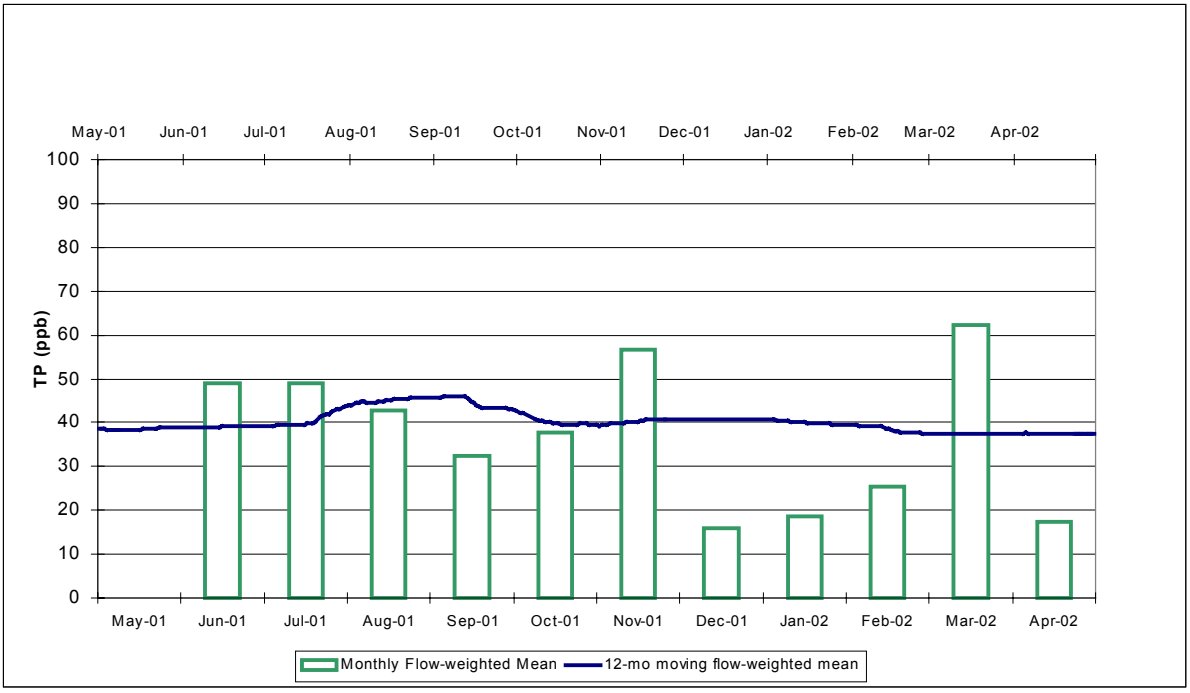



**Figure 4A-6.** Comparison of monthly to 12-month moving average phosphorus concentrations for Water Year 2002 for STA-1W

## Non-Phosphorus Parameters

Water quality parameters with Class III standards are identified in **Table 4A-3**. The monitoring data for non-phosphorus parameters at STA-1W during this reporting period are presented in **Appendix 4A-1** and are summarized in **Table 4A-4**. Compliance with the EFA permit is determined based on the following three-part assessment:

If the annual average outflow concentration does not cause or contribute to violations of applicable Class III water quality standards, then STA-1W shall be deemed in compliance.

If the annual average concentration at the outflow causes or contributes to violations of applicable Class III water quality standards, but does not exceed or is equal to the annual average concentration at the inflow stations, then STA-1W shall be deemed in compliance.

If the annual average concentration at the outflow causes or contributes to violations of applicable Class III water quality standards and also exceeds the annual average concentration at the inflow station, then STA-1W shall be deemed out of compliance.

Discharges from STA-1W were determined to be in compliance by satisfying the initial test.

Additional requirements for dissolved oxygen (DO) are listed in Administrative Order AO-002-EV and are discussed below. Mercury monitoring results are also discussed in a proceeding section.

**Table 4A-3.** Water quality parameters with Class III criteria specified in Section 62-302.530, Florida Administrative Code

| Parameter | Units | Class III Criteria |
|---|---|---|
| Dissolved Oxygen | mg/L | Greater than or equal to 5.0 mg/L |
| Specific Conductivity | µmhos/cm | Not greater than 50% of background or greater than 1,275 µmhos/cm |
| pH | standard units | Not less than 6.0 or greater than 8.5 |
| Turbidity | NTU | Less than or equal to 29 NTU above background conditions |
| Unionized Ammonia | mg/L | Less than or equal to 0.02 mg/L |
| Alkalinity | mg/L | Not less than 20 mg/L |
| Total Iron | µg/L | Less than or equal to 1,000 µg/L |

**Table 4A-4.** Summary of annual arithmetic averages and flow-weighted means for all parameters other than total phosphorus monitored in STA-1W

| Parameter | Arithmetic Means | | | Flow-Weighted Means | | | |
|---|---|---|---|---|---|---|---|
| | Inflow | Outflow | | Total Inflow | | Total Outflow | |
| | S5A | G251 | G310 | n | Conc. | n | Conc. |
| Temperature (°C) | 24.9 | 24.4 | 24.6 | -NA- | -NA- | -NA- | -NA- |
| Dissolved Oxygen (mg/L) | 3.8 | 2.1 | 3.4 | -NA- | -NA- | -NA- | -NA- |
| Specific Conductivity (µmhos/cm) | 1,162 | 1,116 | 1,117 | -NA- | -NA- | -NA- | -NA- |
| pH | 7.5 | 7.5 | 7.5 | -NA- | -NA- | -NA- | -NA- |
| Turbidity (NTU) | 6.5 | 1.9 | 5.2 | -NA- | -NA- | -NA- | -NA- |
| Total Dissolved Solids (mg/L) | 749 | 708 | 700 | 10 (26) | 848 | 18 (52) | 637 |
| Unionized Ammonia (mg/L) | 0.0058 | 0.0020 | 0.0040 | 10 (26) | 0.0093 | 18 (52) | 0.0017 |
| Orthophosphate as P (mg/L) | 0.069 | 0.008 | 0.010 | 10 (26) | 0.127 | 18 (52) | 0.012 |
| Total Dissolved Phosphorus (mg/L) | 0.076 | 0.013 | 0.015 | 10 (26) | 0.135 | 18 (52) | 0.018 |
| Sulfate (mg/L) | 77.2 | 58.4 | 62.3 | 10 (26) | 88.8 | 18 (52) | 61.3 |
| Alkalinity (mg/L) | 263 | 249 | 250 | 10 (26) | 308 | 18 (52) | 228 |
| Dissolved Chloride (mg/L) | 166 | 160 | 157 | 10 (26) | 181 | 18 (52) | 140 |
| Total Nitrogen (mg/L) | 3.03 | 2.46 | 2.51 | 10 (26) | 4.30 | 18 (52) | 2.53 |
| Total Dissolved Nitrogen (mg/L) | 2.85 | 2.35 | 2.36 | 10 (26) | 3.98 | 18 (52) | 2.31 |
| Nitrate + Nitrite (mg/L) | 0.587 | 0.012 | 0.052 | 10 (26) | 1.110 | 18 (52) | 0.026 |
| Ametryn (µg/L) | 0.072 | 0.044 | 0.056 | 1 (6) | 0.069 | 2 (8) | 0.056 |
| Atrazine (ug/L) | 0.625 | 0.471 | 0.513 | 1 (6) | 0.120 | 2 (8) | 0.134 |

-NA- : Not Applicable
n: number of samples with flow (total number of samples)

The District has included the following documentation to satisfy the remaining monitoring requirements of the EFA permit:

- The District has performed all sampling and analysis under the latest FDEP-approved CompQAP No. 870166G (June 1999).
- A signed copy of this statement is provided in **Appendix 4A-2**.

## STA-1 West Dissolved Oxygen Monitoring

### *Introduction*

Dissolved oxygen concentrations fluctuate naturally in marsh environments, such as the Everglades, and routinely fall below the Class III water quality criterion of 5 mg/L. STAs also experience natural fluctuations in DO that routinely fall below 5 mg/L, as was observed in DO data collected in the ENRP (ENR Monitoring Report Appendices, 1995 to 1998). The FDEP recognized the phenomenon of fluctuating DO concentrations in the EFA permit issued to the District for STA-1W (Administrative Order No. AO-002-EV in Exhibit C of Permit No. 503074709, April 13, 1999). To address DO in STA discharges, section II of the administrative orders requires the District to provide the FDEP in an annual report an analysis demonstrating that DO levels in STA discharges do not adversely change the downstream Everglades ecological or downstream water quality, based on the following:

- Comparison of DO levels in STA discharges with background conditions in receiving waters
- Evaluation of DO levels at representative interior Everglades marsh stations, demonstrating that STA discharges fully maintain and protect the existing designated uses of the downstream waters and the level of water quality consistent with applicable anti-degradation requirements
- Evaluation of whether discharges are necessary or desirable and otherwise in the public interest
- Depiction of the daily and seasonal diel cycles for STA DO discharges during the period covered by the STA annual report
- Comparison of STA effluent with other historic DO data from the Everglades Protection Area (EPA), including data from interior marsh stations within the Loxahatchee Refuge (STA-1W), the Rotenberger Tract (STA-5) and any other locations downstream of the STA discharges
- Consideration of the influences of temperature, seasonal weather conditions, aquatic community type, and hydropattern upon the diel cycle of the STA discharges.

### *Sampling Locations*

The following plan was developed by the District to comply with the DO requirements of the administrative orders for STA-1W by measuring DO concentrations with Hydrolab™ DataSonde® or MiniSonde® probes at 30-minute intervals and quarterly for four consecutive days at the following locations:

- On the south side of the C-51 canal upstream of S-5A (**Figure 4A-2**)
- Downstream of the G-251 and G-310 discharge structures (**Figure 4A-2**)

- At sites along the X, Y and Z transects in the periphery of the interior Arthur R Marshall Loxahatchee National Wildlife Refuge marshes downstream of the combined discharges (**Figure 4A-7**).

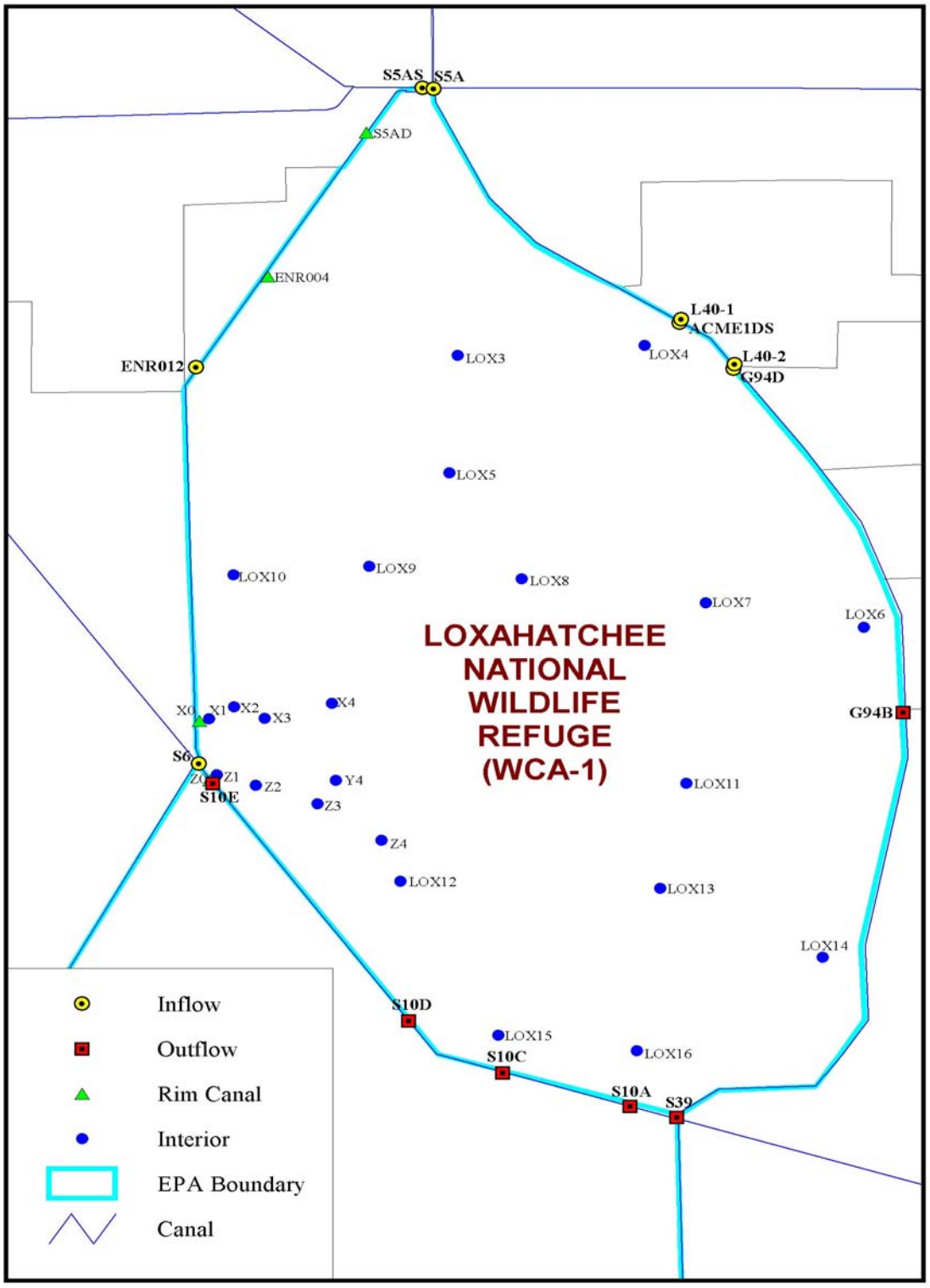



**Figure 4A-7.** Location and classification of water quality monitoring stations in the Arthur R. Marshall Loxahatchee National Wildlife Refuge

### *Sampling Dates*

Diel oxygen measurement dates and sites for Water Year 2002 are provided in **Table 4A-5**.

**Table 4A-5.** Deployment dates for diel oxygen measurements at STA-1W structures and associated downstream marsh sites

| Event Dates | | Structures | | | Sites Monitored in Refuge |
|---|---|---|---|---|---|
| Start | End | Inflow | Outflow | | |
| 05/07/2001 | 05/14/2001 | S5AU | G251D | G310 | ---------- |
| 07/11/2001 | 07/17/2001 | S5AU | G251D | G310 | X1, X2, X3, Z1, Z2, Z3, Z4 |
| 10/08/2001 | 10/12/2001 | S5AU | G251D | G310 | X1, X2, X3, X4, Y4, Z1, Z2, Z3, Z4, MESO01 |
| 12/12/2001 | 12/17/2001 | S5AU | G251D | G310 | ---------- |
| 01/03/2002 | 01/09/2002 | S5AU | G251D | G310 | ---------- |
| 01/23/2002 | 01/28/2002 | ------ | ------ | ------ | X1, X2, X3, X4, Y4, Z1, Z2, Z3, Z4, MESO01 |
| 04/02/2002 | 04/09/2002 | S5AU | G251D | G310 | ---------- |
| 04/22/2002 | 04/26/2002 | ------ | ------ | ------ | X1, Y4, Z1, Z3, MESO01 |

### *Comparison Of Dissolved Oxygen In STA-1W Discharges With Dissolved Oxygen at Downstream Marsh Sites*

Comparisons of DO in STA-1W discharges with DO at downstream marsh sites in the Refuge provide an indication of whether the discharge is affecting the marsh DO concentration or the diel oxygen cycle. The summary statistics for STA-1W outflows and Refuge marsh transect sites are presented in **Table 4A-6**. The complete DO data sets collected at all sites during WY02 are presented in **Appendix 4A-3**. Examination of this table indicates that the median diel DO values of discharges from G-251 and G-310 were greater than transects sites X1, X3, X4, Y4, Z1, Z2 and Z4.

**Table 4A-6.** Statistical summary of diel dissolved oxygen at outflow stations (G-251D and G-310) and transect stations (X, Y, Z and mesocosm) in the Refuge during eight deployment periods

| Location | Station | Number of Measurements | Mean | Minimum | Median | Maximum | Standard Deviation |
|---|---|---|---|---|---|---|---|
| Outflow | G251D | 1,663 | 3.74 | 0.25 | 3.49 | 7.45 | 1.58 |
| | G310 | 1,664 | 4.44 | 0.84 | 4.19 | 8.45 | 1.77 |
| Transect X | X1 | 605 | 2.60 | 0.11 | 1.87 | 12.44 | 2.43 |
| | X3 | 619 | 3.02 | 0.65 | 2.53 | 8.20 | 1.61 |
| | X4 | 422 | 3.92 | 1.77 | 3.31 | 8.68 | 1.54 |
| Transect Y | Y4 | 607 | 3.10 | 0.24 | 3.05 | 7.01 | 1.58 |
| Transect Z | Z1 | 802 | 1.15 | 0.01 | 0.84 | 3.56 | 1.03 |
| | Z2 | 619 | 3.83 | 0.29 | 3.44 | 14.43 | 2.82 |
| | Z3 | 606 | 4.60 | 0.34 | 4.96 | 8.30 | 1.85 |
| | Z4 | 620 | 3.71 | 0.9 | 3.52 | 7.06 | 1.41 |
| Mesocosm | MESO01 | 500 | 5.44 | 1.31 | 5.55 | 8.94 | 1.32 |

See **Appendix 4-4**, Table 2 for statistical summaries by event and diel parameter

Notched box and whisker plots were created from the data in **Table 4A-5** as another method for analyzing differences between monitoring sites. The median diel DO concentrations in the discharges from G-251 were significantly greater than the median diel DO concentrations at marsh sites Z1, X1, X3, and Y4. Diel DO concentrations in G-310 discharges were also significantly greater than those at marsh sites Z2, Z4, and X4, leaving only marsh sites Z3 and MESO01 with significantly higher concentrations than those in the discharges (**Figure 4A-8)**. The notched box plots also show that the diel DO concentrations in the Refuge significantly improve from the impacted sites near the L-7 rim canal (X1 and Z1) to the interior sites.

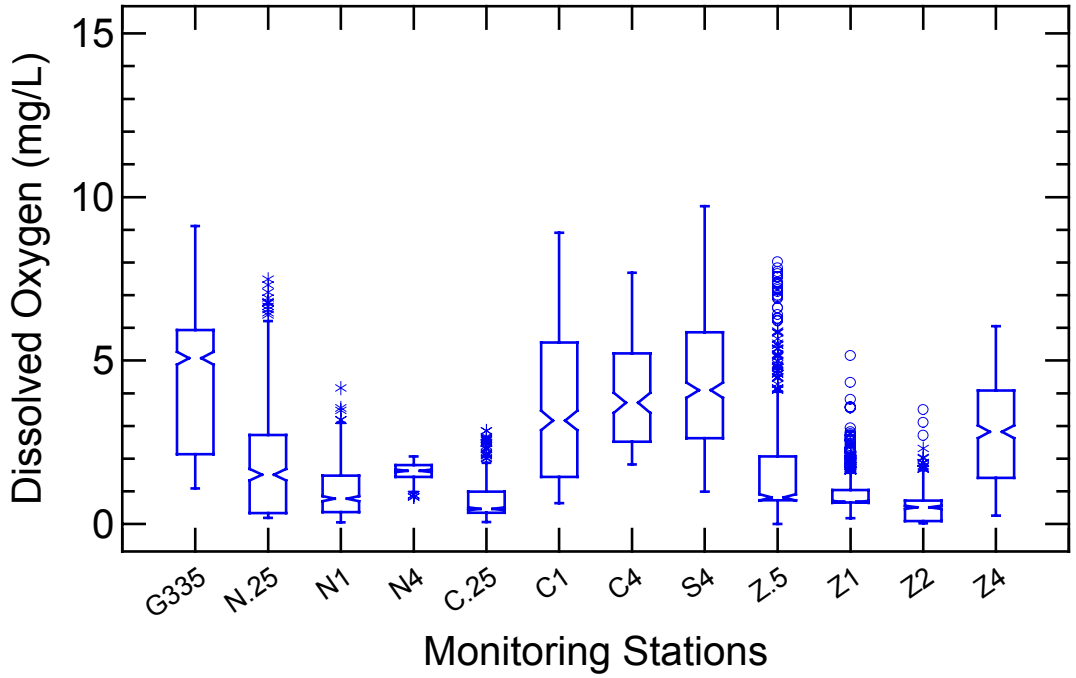



**Figure 4A-8**. Notched-box and whisker plots of diel dissolved oxygen measurements at the STA-2 outflow station (G-335) and along transect sites in Water Conservation Area 2 during three monitoring periods The notch on a box plot represents the 95-percent confidence interval about the median, which is represented by the narrowest part of the notch. The top and bottom of the box represent the 75$^{th}$ and 25$^{th}$ percentiles, respectively. The whiskers represent the highest and lowest data values that are within two standard deviations of the median. Values above and below the whiskers are greater than two standard deviations from the median. Notches that do not overlap indicate that the data represented by the boxes being compared are significantly different at the 95-percent confidence level

Based on the data presented, it appears that the diel DO concentrations in the STA-1W discharges did not affect the low DO concentrations observed at marsh transect stations. The diel DO patterns observed at transect sites X1 and Z1 are largely due to the long-term effects of TP loading to the rim canal. Patterns at the more interior transect sites are the result of water depth and habitat vegetation differences. Ultimately, TP load reductions to the Refuge should improve DO conditions at the transect sites affected by rim canal water penetration into the marsh.

### STA-1 West Mercury

The results of mercury compliance monitoring for routine operation are summarized in **Appendix 4A-4** of this chapter. During Water Year 2002 there were no violations of the Florida Class III numerical water quality standard of 12 ng/L unfiltered total mercury (THg). As such, the Everglades Construction Project (ECP) has met one of the requirements of the operating permits.

Like the ENR Project it subsumed, STA-1W continued to have only low concentrations of methylmercury (MeHg) in surface water, consistently showed both Hg and MeHg reduction across the STA, and exhibited greatly reduced MeHg bioaccumulation in resident fish relative to other STAs and other areas of the Everglades.

## STA-2

STA-2 contains approximately 6,430 acres of effective treatment area, arranged in three parallel flow-ways. The eastern flow-way (cell 1) consists of approximately 1,990 acres of effective treatment area. The center flow-way (cell 2) consists of approximately 2,220 acres of effective treatment area. The western flow-way (cell 3) consists of approximately 2,220 acres of effective treatment area. A schematic of STA-2 is presented in **Figure 4A-9**. Based on the 1979-88 period of flow and phosphorus data used during design, the STA should receive approximately 163,000 acre feet from the S-6 and S-5A basins, approximately 8,300 acre feet from the East Shore Water Control District and Closter Farms, approximately 3,000 acre feet of Lake Okeechobee regulatory releases, and BMP replacement water from the Lake. Actual deliveries will vary based on hydrologic conditions in the basins.

Water enters the STA from the S-6 and G-328 pump stations, is distributed by the inflow canal across the north end of the treatment cells, and flows via gravity south through the three treatment cells. Treated water is collected and discharged to WCA-2A via the G-335 outflow pump station. Discharges are directed to areas within WCA-2A that are already impacted by elevated nutrient levels.

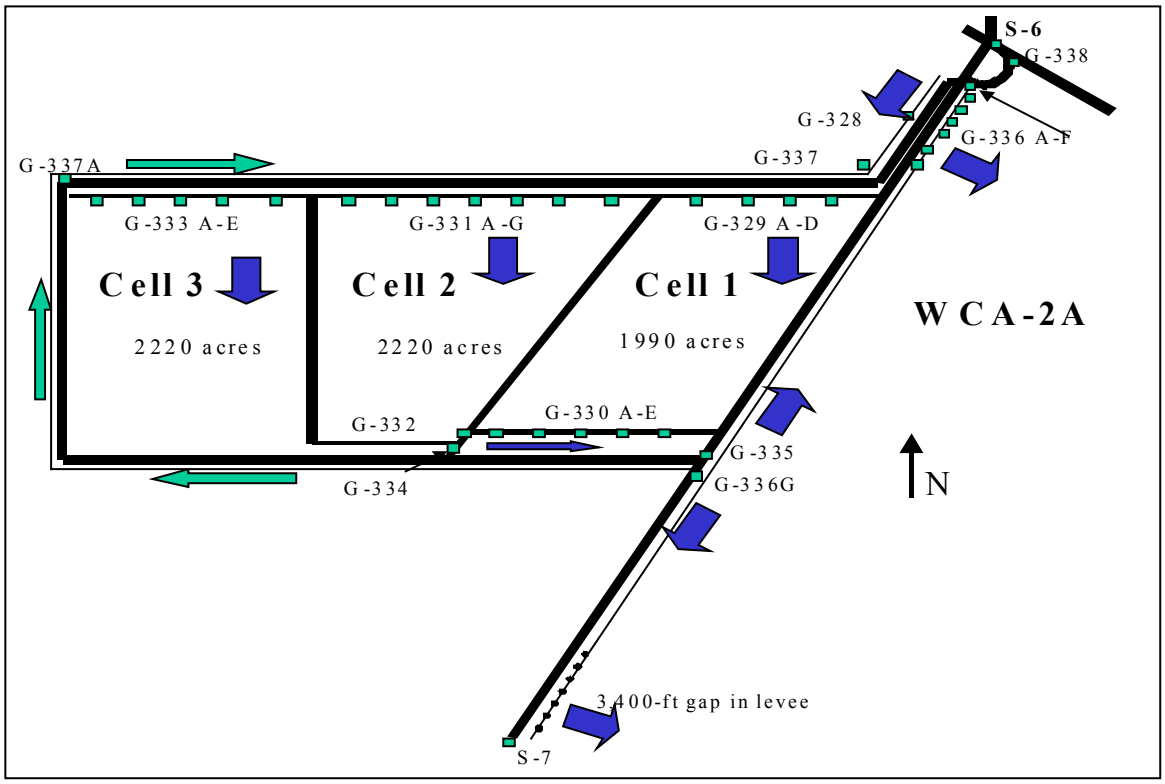
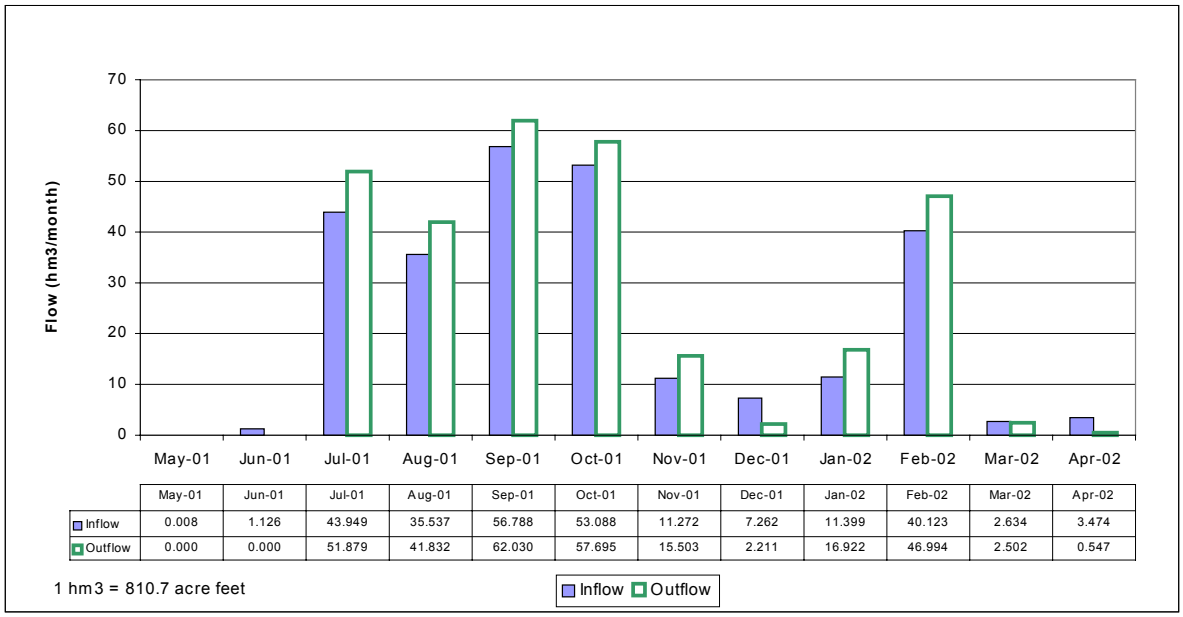



**Figure 4A-9.** Schematic of STA-2 (not to scale)

## STA-2 OPERATIONS

Startup operations for STA-2 began upon the completion of the three treatment cells in 1999. Inflow to the STA commenced in June 1999 from the 450-cfs pump station G-328; water levels were maintained for optimal growth of desired vegetation. Construction of the 3,040-cfs outflow pump station (G-335) was completed in 2000, with final operational testing taking place in October 2000. The final construction component, connection of the S-6 pump station to the inflow canal, was completed during the dry season of 2001, a schedule that minimized the potential down time of pump station S-6. The outflow structures in cell 1 (G-330s) are being fitted with weir plates to increase water depths in the cell, which should reduce the frequency and duration of drydowns within the cell.

During WY02, approximately 267 cubic hm (216,185 acre feet) of water was captured and treated by STA-2, equal to an average hydraulic load of 2.8 cm/day over the treatment area. The annual volume of treated water discharged to WCA-2A was 298 cubic hectometers (241,686 acre feet), or about 120 percent of the anticipated average annual flow for the treatment area. The difference between the inflow and outflow volumes reflects the net contributions of direct rainfall, ET, seepage losses to the adjacent lands, and deep percolation. A summary of monthly flows is presented in **Figure 4A-10**.




| | May-01 | Jun-01 | Jul-01 | Aug-01 | Sep-01 | Oct-01 | Nov-01 | Dec-01 | Jan-02 | Feb-02 | Mar-02 | Apr-02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow | 0.008 | 1.126 | 43.949 | 35.537 | 56.788 | 53.088 | 11.272 | 7.262 | 11.399 | 40.123 | 2.634 | 3.474 |
| Outflow | 0.000 | 0.000 | 51.879 | 41.832 | 62.030 | 57.695 | 15.503 | 2.211 | 16.922 | 46.994 | 2.502 | 0.547 |

**Figure 4A-10.** Summary of Water Year 2002 flows for STA-2

## STA-2 VEGETATION

Water levels in STA-2 are managed to protect the established wetland plant community within each treatment cell. Cells 1 and 2 in STA-2 are dominated by emergent vegetation, such as sawgrass (*Cladium jamaicense*), with some cattail (*Typha sp.*). Cell 3 is maintained to promote the growth of submerged aquatic vegetation (SAV).

Specific Condition 27 of the EFA permit also requires the District to report information regarding the application of herbicides and pesticides used to control undesirable vegetation and pests within the project. For this reporting period, 40 gallons of the herbicide Arsenal EUP, 80 gallons of the herbicide Glyphosate and 85 gallons of various adjuvants (inert liquids used to help distribute the herbicide) were applied in STA-2 to control old world climbing fern (Lygodium microphyllum), Brazilian Pepper (Schinus terebinthifolius) and other nuisance vegetation. All herbicides were applied using aerial spray equipment.

## STA-2 PERMIT WATER QUALITY MONITORING

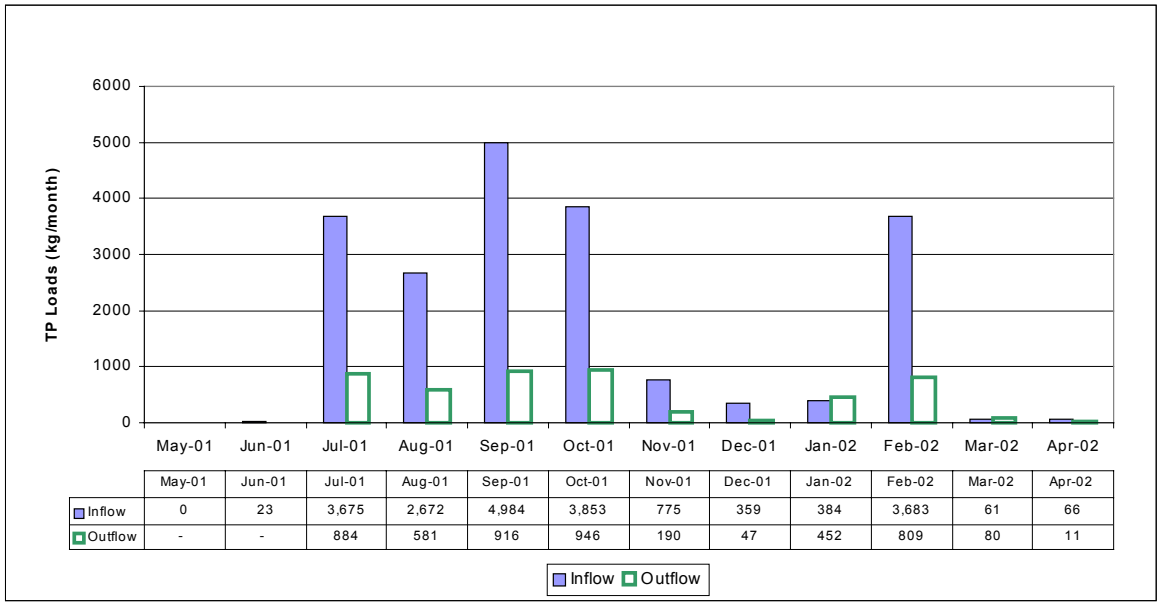
Monitoring data collected for STA-2 demonstrate that STA-2 was in compliance with the EFA and NPDES operating permits for WY02 and that discharges do not pose any known danger to public health, safety, or welfare. Cell 2 and cell 3 are in the stabilization phase, having demonstrated net improvement in phosphorus and mercury. However, although cell 1 has demonstrated a net improvement in phosphorus it will remain in the startup phase until it demonstrates a net improvement in mercury, as discussed in greater detail below. In addition, Specific Condition 14(B) of the EFA permit states that STA-2 will remain in the stabilization phase of operation until STA-1E and STA-3/4 begin flow-through operations. At this time, STA-1E and STA-3/4 are still in the construction phase and are not expected to begin flow-through operations until late 2003 through early 2005, subject to vegetation grow-in and soil phosphorus stabilization.

### Total Phosphorus

The EFA and NPDES operating permits were issued for this project on September 29, 2000. Each treatment cell in STA-2 operates independently, and the permit authorizes discharges when net improvement in TP and mercury is demonstrated for each cell. STA-2 cells 2 and 3 passed the net improvement startup test for TP and mercury on September 13 and November 9, 2000, respectively. STA-2 cell 1 passed the startup test for TP, but did not pass the startup criteria for mercury. After review of the cell 1 mercury situation by the FDEP, the USEPA, and other agencies, it was determined that the most effective way to reduce mercury concentrations in cell 1 was to move as much water through the cell as possible to increase sulfur levels. On August 9, 2001 a draft permit modification was issued to initiate flow-through operations for cell 1.

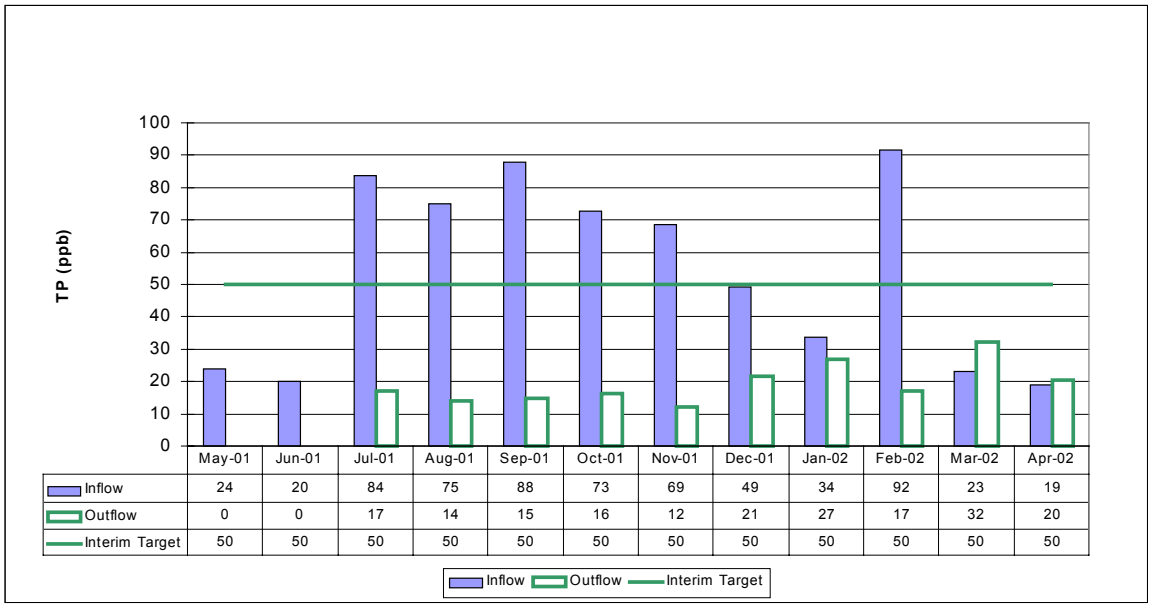
Under the design objectives of the Everglades Forever Act, STA-2 is achieving its interim discharge goal of less than 50 ppb for total phosphorus. During WY02, the STA received 20.5 metric tons of phosphorus, equal to a nutrient-loading rate of 0.80 grams/sq m. Approximately 15.6 metric tons of TP were removed by STA-2 during WY02. Monthly discharge concentrations were considerably lower than inflow concentrations, and between May 2001 and April 2002 STA-2 reduced discharge loads of total phosphorus by 76 percent. A summary of monthly TP loads and flow-weighted mean TP concentrations are presented in **Figures 4A-11** and **4A-12**. The flow-weighted mean outflow concentration was 16 ppb, a 79-percent reduction from the inflow concentration of 77 ppb. For informational purposes, the geometric mean discharge phosphorus concentrations for STA-2 was 20 ppb for Water Year 2002. By virtue of achieving an outflow

concentration of less than 50 ppb in accordance with the EFA permit for STA-2, cells 2 and 3 would have been deemed past the stabilization phase were it not for the requirement that STA-2 remain in the stabilization phase until STA-1E and STA-3/4 begin full flow-through operation. The initial 12-month moving average phosphorus concentration from STA-2 was 16 ppb.




| | May-01 | Jun-01 | Jul-01 | Aug-01 | Sep-01 | Oct-01 | Nov-01 | Dec-01 | Jan-02 | Feb-02 | Mar-02 | Apr-02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow | 0 | 23 | 3,675 | 2,672 | 4,984 | 3,853 | 775 | 359 | 384 | 3,683 | 61 | 66 |
| Outflow | - | - | 884 | 581 | 916 | 946 | 190 | 47 | 452 | 809 | 80 | 11 |

**Figure 4A-11.** Summary of Water Year 2002 phosphorus loads for STA-2




| | May-01 | Jun-01 | Jul-01 | Aug-01 | Sep-01 | Oct-01 | Nov-01 | Dec-01 | Jan-02 | Feb-02 | Mar-02 | Apr-02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow | 24 | 20 | 84 | 75 | 88 | 73 | 69 | 49 | 34 | 92 | 23 | 19 |
| Outflow | 0 | 0 | 17 | 14 | 15 | 16 | 12 | 21 | 27 | 17 | 32 | 20 |
| Interim Target | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |

**Figure 4A-12.** Summary of Water Year 2002 phosphorus concentrations for STA-2

## Non-Phosphorus Parameters

The monitoring data for non-phosphorus parameters at STA-2 during this reporting period are presented in **Appendix 4A-5** and are summarized in **Table 4A-7**. Compliance with the EFA permit is determined based on the following three-part assessment:

If the annual average outflow concentration does not cause or contribute to violations of applicable Class III water quality standards, then STA-2 shall be deemed in compliance.

If the annual average concentration at the outflow causes or contributes to violations of applicable Class III water quality standards, but does not exceed or is equal to the annual average concentration at the inflow stations, then STA-2 shall be deemed in compliance.

If the annual average concentration at the outflow causes or contributes to violations of applicable Class III water quality standards and also exceeds the annual average concentration at the inflow station, then STA-2 shall be deemed out of compliance.

Discharges from STA-2 were determined to be in compliance by satisfying the initial test.

Additional requirements for dissolved oxygen are listed in Administrative Order AO-006-EV and are discussed below. Mercury monitoring results are also discussed in a proceeding section.

The District has included the following documentation to satisfy the remaining monitoring requirements of the EFA permit:

- The District has performed all sampling and analysis under the latest FDEP-approved CompQAP No. 870166G (June 1999).
- A signed copy of this statement, prepared by Maxine Cheesman, director of the Water Quality Monitoring Department, Division of Environmental Monitoring and Assessment, SFWMD, and the individual responsible for implementation of the sampling program during this period, is provided in **Appendix 4A-2**.

**Table 4A-7.** Summary of annual arithmetic averages and flow-weighted means for all parameters other than total phosphorus monitored in STA-2

| Parameter | Arithmetic Means | | | Flow-Weighted Means | | | |
|---|---|---|---|---|---|---|---|
| | Inflow | | Outflow | Total Inflow | | Total Outflow | |
| | S6 | G328 | G335 | n | Conc. | n | Conc. |
| Temperature (°C) | 24.8 | 25.0 | 25.3 | -NA- | -NA- | -NA- | -NA- |
| Dissolved Oxygen (mg/L) | 3.1 | 3.6 | 4.8 | -NA- | -NA- | -NA- | -NA- |
| Specific Conductivity (µmhos/cm) | 1,186 | 1,534 | 1,275 | -NA- | -NA- | -NA- | -NA- |
| pH | 7.4 | 7.5 | 7.7 | -NA- | -NA- | -NA- | -NA- |
| Turbidity (NTU) | 3.5 | 4.5 | 6.0 | -NA- | -NA- | -NA- | -NA- |
| Total Dissolved Solids (mg/L) | 780 | 972 | 791 | 15 (42) | 809 | 15 (21) | 744 |
| Unionized Ammonia (mg/L) | 0.0052 | 0.0075 | 0.0023 | 15 (42) | 0.0069 | 14 (19) | 0.0014 |
| Orthophosphate as P (mg/L) | 0.025 | 0.010 | 0.005 | 16 (44) | 0.063 | 15 (21) | 0.006 |
| Total Dissolved Phosphorus (mg/L) | 0.030 | 0.012 | 0.008 | 15 (42) | 0.066 | 15 (21) | 0.008 |
| Sulfate (mg/L) | 61.1 | 47.7 | 47.1 | 15 (42) | 72.6 | 15 (21) | 45.5 |
| Alkalinity (mg/L) | 315 | 380 | 306 | 16 (44) | 338 | 15 (21) | 285 |
| Dissolved Chloride (mg/L) | 161 | 259 | 187 | 16 (44) | 161 | 15 (21) | 181 |
| Total Nitrogen (mg/L) | 2.97 | 2.68 | 2.44 | 16 (43) | 4.34 | 15 (21) | 2.28 |
| Total Dissolved Nitrogen (mg/L) | 2.87 | 2.56 | 2.32 | 15 (41) | 4.07 | 15 (21) | 2.19 |
| Nitrate + Nitrite (mg/L) | 0.451 | 0.332 | 0.113 | 16 (43) | 1.263 | 15 (21) | 0.120 |

-NA- : Not Applicable
n: number of samples with flow (total number of samples)

## Dissolved Oxygen Monitoring

### *Introduction*

STA-2 Administrative Order No. AO-006-EV in Exhibit C of the EFA STA-2 permit (permit No. 0126704, September 29, 2000) specifies the same dissolved oxygen monitoring requirements as for STA-1W. The following plan was developed by the District to comply with the DO requirements of the administrative orders for STA-2 by measuring DO concentrations with Hydrolab™ DataSonde®, or MiniSonde® probes at 30-minute intervals and quarterly for four consecutive days at the following locations:

- At the inflow side of the S-6 pump station
- At the inflow side of the G-328 pump station
- At sites along the N, C, S and Z transects in the northwest section of WCA-2A, located downstream of culverts distributing flow from discharge pump station G-335

Diel oxygen measurement dates and sites for Water Year 2002 are provided in **Table 4A-8**.

**Table 4A-8.** Deployment dates for diel oxygen measurement at STA-2 structures and associated downstream marsh sites

| Event Dates | | Structures | | | Sites Monitored in Water Conservation Area 2 |
|---|---|---|---|---|---|
| Start | End | Inflow | | Outflow | |
| 09/05/2001 | 09/12/2001 | S6 | G328 | G335 | C.25, C1, N.25, N1, S4, Z.5, Z1, Z2, Z4 |
| 11/15/2001 | 11/21/2001 | S6 | G328 | G335 | C.25, C1, N.25, N1, S4, Z.5, Z1, Z2, Z4 |
| 03/06/2002 | 03/13/2002 | S6 | G328 | G335 | ---------- |

### *Comparison Of Dissolved Oxygen in STA-2 Discharges With Dissolved Oxygen at Downstream WCA-2A Sites*

Comparisons of DO in STA-2 discharges with DO at downstream marsh sites in WCA-2A provide an indication of whether the discharge is affecting the marsh DO concentration or the diel oxygen cycle. The summary statistics for STA-2 outflows and WCA-2A marsh transect sites are presented in **Table 4A-9**. The complete data sets collected at all sites during WY02 are in **Appendix 4A-6**. Examination of this table shows that the median diel dissolved oxygen concentration in the G-335 discharges was greater than any of the marsh site median concentrations on transects N, C, S and Z. In addition, the minimum diel dissolved oxygen concentration in the G-335 discharges was greater than all the marsh site minimum concentrations, with the exceptions of C-4.

**Table 4A-9.** Statistical summary of diel dissolved oxygen at the outflow pump stations from STA-2 and marsh stations in WCA-2 during WY02

| Location | Station | Number of Measurements | Mean | Minimum | Median | Maximum | Standard Deviation |
|---|---|---|---|---|---|---|---|
| **Outflow** | G335 | 951 | 4.44 | 1.09 | 5.07 | 9.11 | 1.88 |
| | N.25 | 471 | 1.83 | 0.19 | 1.51 | 7.49 | 1.65 |
| **Transect N** | N1 | 471 | 1.02 | 0.05 | 0.78 | 4.16 | 0.79 |
| | N4 | 187 | 1.59 | 0.83 | 1.63 | 2.07 | 0.29 |
| | C.25 | 471 | 0.71 | 0.06 | 0.47 | 2.85 | 0.55 |
| **Transect C** | C1 | 471 | 3.58 | 0.64 | 3.17 | 8.91 | 2.29 |
| | C4 | 187 | 3.95 | 1.83 | 3.71 | 7.69 | 1.56 |
| **Transect S** | S4 | 470 | 4.44 | 0.99 | 4.10 | 9.72 | 2.12 |
| | Z.5 | 469 | 1.67 | 0.01 | 0.82 | 8.02 | 1.81 |
| **Transect Z** | Z1 | 469 | 0.93 | 0.18 | 0.68 | 5.15 | 0.71 |
| | Z2 | 470 | 0.53 | 0.03 | 0.52 | 3.50 | 0.50 |

See **Appendix 4-4**, **Table 3** for statistical summaries by event and diel parameter.

Notched box and whisker plots were created from the data in **Table 4A-9** to compare the DO concentrations in the G-335 discharges with the marsh transect sites concentrations. The median diel DO concentration for G-335 was significantly greater than the median diel DO concentrations at all of the marsh transect sites (**Figure 4A-13**). The notched box plots also show that the DO concentrations at marsh transect sites C1, C4, S4, and Z4 are significantly greater than the DO concentrations at marsh sites N25, N1, N4, C25, Z5, Z1, and Z2. This indicates that the vegetative community in which diel dissolved oxygen concentrations are measured can have an effect on the resulting diel curve characteristics, particularly if there is evidence that the site had been previously impacted by discharges containing high total phosphorus concentrations (**Figure 4A-14**).

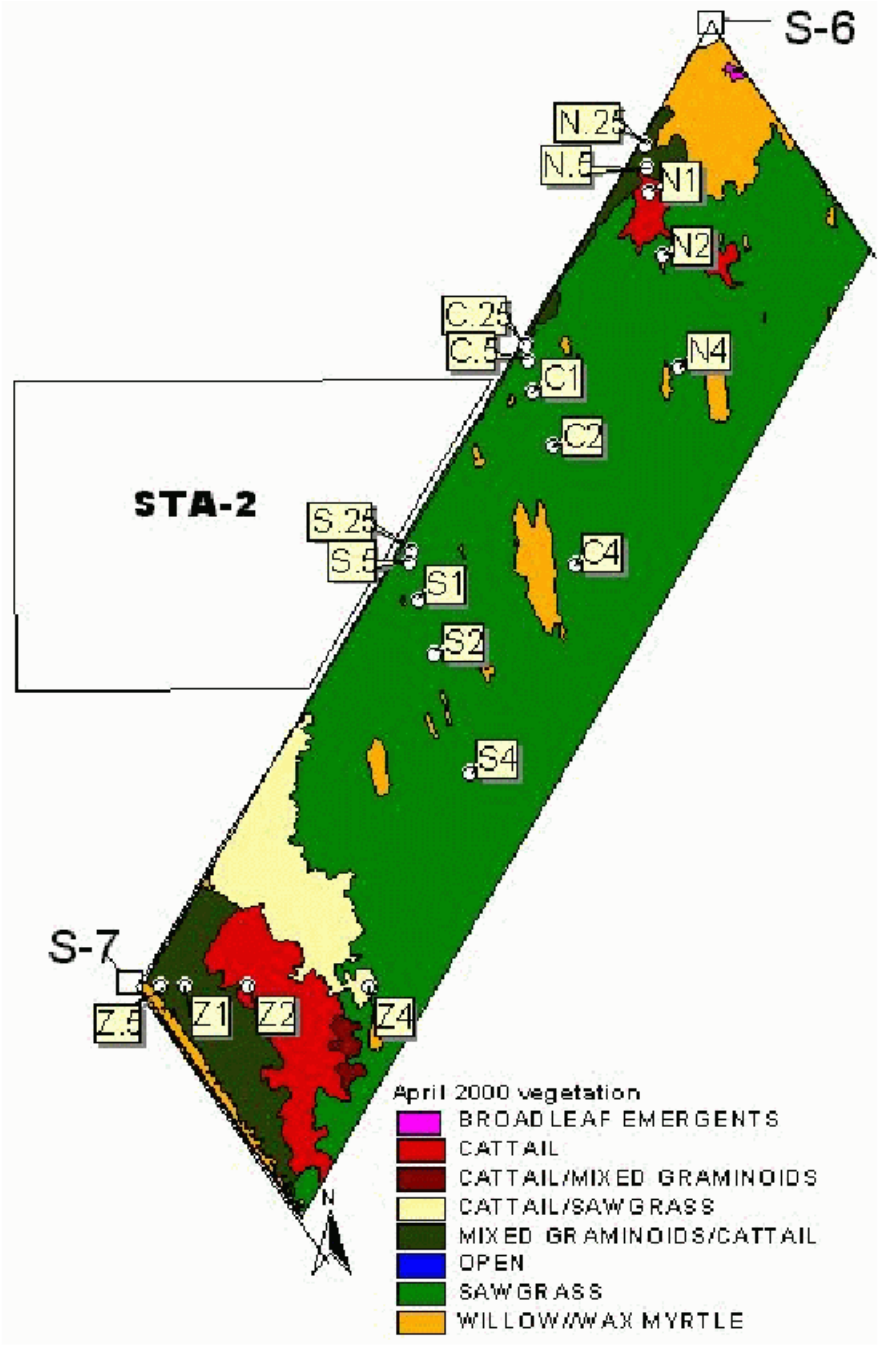



**Figure 4A-13.** Dissolved oxygen monitoring sites in WCA-2

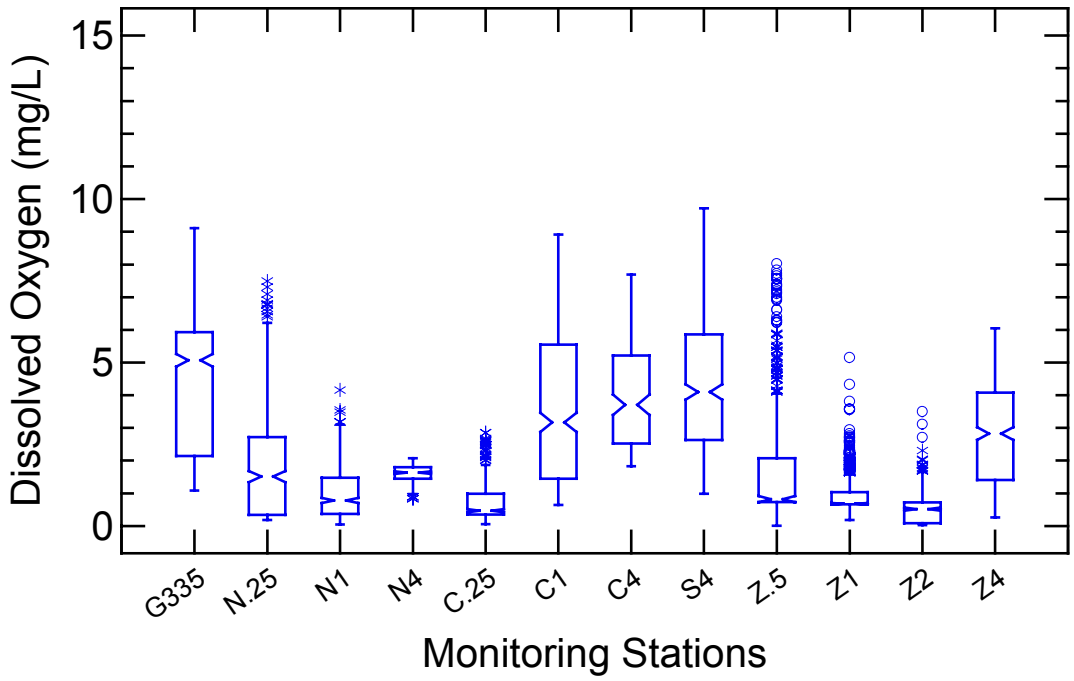



**Figure 4A-14**. Notched-box and whisker plots of diel dissolved oxygen measurements at the STA-2 outflow station (G-335) and along transect sites in Water Conservation Area 2 during three monitoring periods The notch on a box plot represents the 95-percent confidence interval about the median, which is represented by the narrowest part of the notch. The top and bottom of the box represent the 75$^{th}$ and 25$^{th}$ percentiles, respectively. The whiskers represent the highest and lowest data values that are within two standard deviations of the median. Values above and below the whiskers are greater than two standard deviations from the median. Notches that do not overlap indicate that the data represented by the boxes being compared are significantly different at the 95-percent confidence level.

Based on the data presented, it appears that the diel DO concentrations in the STA-2 discharges did not affect the low DO concentrations observed at marsh transect stations X1, X2, Z1 and Z2. The diel DO patterns observed at these transect sites are probably due primarily to the long-term effects of TP loading. It is anticipated that TP load reductions in STA-2 should improve DO conditions at these transect sites.

## Mercury

The results of mercury compliance monitoring for routine operation are summarized in **Appendix 4A-4** of this chapter. During Water Year 2002, there were no violations of the Florida Class III numerical water quality standard of 12 ng/L unfiltered total mercury (THg). As such, the Everglades Construction Project has met one of the requirements of the operating permits. However, STA-2 cell 1 still did not meet its net improvement test during WY02.

The occurrence and reporting of an anomalous mercury event in STA-2 cell 1 are summarized in the next subsection. The outflow concentrations of unfiltered THg and methylmercury (MeHg) for Water Year 2002 in cells 2 and 3 were not statistically or environmentally significantly higher than the inflow concentrations. For total mercury, levels in the outflow of cells 2 and 3 are likely attributable to the contribution from wet and dry atmospheric deposition of mer

cury, which probably accounts for more than two-thirds of the THg load into cells 2 and 3 annually. This is not the case for MeHg, which is probably being produced from the fresh supply of "new" inorganic mercury in atmospheric deposition. Nevertheless, the mosquitofish, sunfish, and largemouth bass collected in these cells contain lower Hg concentrations than the Everglades-wide average, so there is, as yet, no cause for concern. This is not the cause for STA-2 cell 1, however, which is the focus of discussion in the next subsection.

## Cell 1 Anomalous Mercury Event

Condition (6)i of Exhibit D of the EFA permit for STA-2 requires the District to report anomalously high mercury concentrations. One such event occurred in Water Year 2002. In July 2001 the District petitioned the FDEP to allow initiation of flow-through operation of cell 1 prior to passing the net improvement startup test. This was intended to accelerate stabilization of cell 1 MeHg by creating conditions designed to reduce production. In August 2001, the FDEP approved the District's request, with conditions for expanded monitoring of and reporting for STA-2 cell 1. The District detected an anomalous mercury event in STA-2 cell 1 in October 2001 and reported it to the FDEP immediately after the data underwent a quality assurance review. Because the dry season was just beginning and there was no certainty that water levels could be held sufficiently high to discourage wading bird feeding in cell 1, the District concluded that it was prudent at that time to drawdown and dryout cell 1 rather than allow the excess MeHg in sediment and water to magnify up the aquatic food chain to levels that might present an unacceptable risk to fish-eating wildlife foraging in cell 1. Dryout began the first week in December 2001 and was essentially complete a month later, though some pools remained on the western side of cell 1 throughout most of the dry season due to the sloping topography; some discharge continued as water was drawn out of the soil below grade. Additional details of this anomalous event are presented in Chapter 2B.

Results from the expanded monitoring of mercury in surface water and fish tissues strongly indicated that anomalous methylmercury production was restricted to cell 1. Details are provided in **Appendix 4A-7**. A positive gradient was observed in MeHg levels in surface water and fish tissues from the inflow in the north to the outflow in the southern portion of cell 1 and, consequently, site C-1A was found not to be representative of conditions within STA-2 cell 1. Further, due to the configuration and design of cell outlets a single grab sample upstream of the outflow pump at G-335 was found to be unrepresentative of discharge under steady state flow. The dramatic fluctuations and concentrations of THg and MeHg in the discharge canal decreased following drawdown and reduction in discharge from cell 1. A gradient in cell-1 stage may have resulted in relatively shallow depths in the southern portion of the cell, and this may, in turn, have had an effect on sediment biogeochemistry and, in particular, redox and mercury methylation. Mercury levels in STA-2 fish exhibited spatial patterns consistent with patterns observed in surface water concentrations. Average mercury concentrations in sunfish caught in a swale in cell 1 in April 2002, which was otherwise dry, were twice the basin-wide mean concentration for sunfish. Levels of mercury in largemouth bass were also elevated relative to other STAs and downstream sites, with the expected mean concentration in a three-year-old fish from the discharge canal at 1148 ng/g. Fortunately, the area of contact and the exposure potential were lowered substantially by draining cell 1.

The District and FDEP have been working together to better understand the cause of this anomalous mercury event and identify short-term and long-term measures to reduce the magnitude and duration of excessive MeHg production, exposure, and export within cell 1 and the receiving waters. The primary management action taken was to raise the elevation of the outlet weir

crests in order to minimize the frequency and magnitude of dryout events. These retrofits were completed at the end of July 2002.

To better understand the causes and to identify short-term and long-term measures to reduce the magnitude and duration of excessive MeHg production, exposure, and export within STA-2 cell 1 and the receiving waters, three joint initiatives are now underway, and several more are planned. The first was to expand the biweekly mercury monitoring of the STA-2 inflow and cell 1 outflow to include the outflows from cells 2 and 3. This allowed the District to confirm that cell 1 was the source of the high MeHg concentrations detected in the STA-2 discharge canal at G-335. That expanded monitoring continues with in-kind analytical support from FDEP's ultra-trace mercury laboratory in Tallahassee. With the onset of flow-through operation in the wet season, interior marsh monitoring of surface water, pore water, soils, and mosquitofish will be added to the inflow and outflow monitoring. The District also secured grant funding from FDEP to partially reimburse the District for the cost of the expanded mercury monitoring (about $500K in FY02 and FY03). The second initiative used an existing modeling contract to model the production, bioaccumulation, export, and potential downstream impacts of the first anomalous mercury event in STA-2 cell 1 that occurred in the fall of 2000. Those results were available at the end of May 2001. The third initiative involved the issuance of a Cooperative Agreement with the U.S. Geological Survey (Dave Krabbenhoft, Ph.D., William Orem, Ph.D., and co-workers) and the Academy of Natural Sciences Environmental Research Laboratory (Cynthia Gilmour, Ph.D. and co-workers) to carry out a study of the effect of dryout duration on the MeHg production with associated analyses of surface water, pore water, and soil chemistries. A report on the preliminary results is due at the end of June 2002 and will be reported in next year's *Everglades Consolidated Report*.

Though not yet underway, proposed initiatives for FY03 include: (1) more detailed modeling of the anomalous mercury event to evaluate operational alternatives that might reduce its magnitude, duration, and frequency of occurrence, and, if needed (2) an in situ mesocosm study of the effect of canal water chemistry and modifications thereto on MeHg production and bioaccumulation in STA-2 cell 1 soils.

## STA-3/4

Construction on STA-3/4 commenced in November 2000 with the award of the inflow pump station's equipment contract. STA-3/4 will use the existing S-7 and S-8 pump stations as the outflow facilities; refurbishment of those stations is underway. Management of all construction dewatering and rainfall is directed at developing vegetation in the interior cells such that startup operations should begin several months before the October construction completion date. A schematic of STA-3/4 is presented in **Figure 4A-15**. Based on the 1979-88 period of flow and phosphorus data used during design, the STA should receive approximately 324,000 acre feet from the S-7 and S-8 basins, approximately 12,200 acre feet from the Ch. 298 Districts along the Lake, approximately 252,000 acre feet of Lake Okeechobee regulatory releases, and BMP replacement water from the Lake. Actual deliveries will vary based on hydrologic conditions in the basins.

While all construction is currently scheduled to be completed by the October 1, 2003 date mandated by the Everglades Forever Act, during WY02, the contractor on three of the STA-3/4 construction components filed for bankruptcy. A new contractor purchased the firm and has submitted a recovery schedule that shows substantial completion by the original October 2003 date. District staff are reviewing the recovery schedule at this time.

No pre-operational soil samples were collected for mercury analysis during the reporting year, because STA-3/4 construction has not yet been completed. Samples will be collected during the upcoming year.

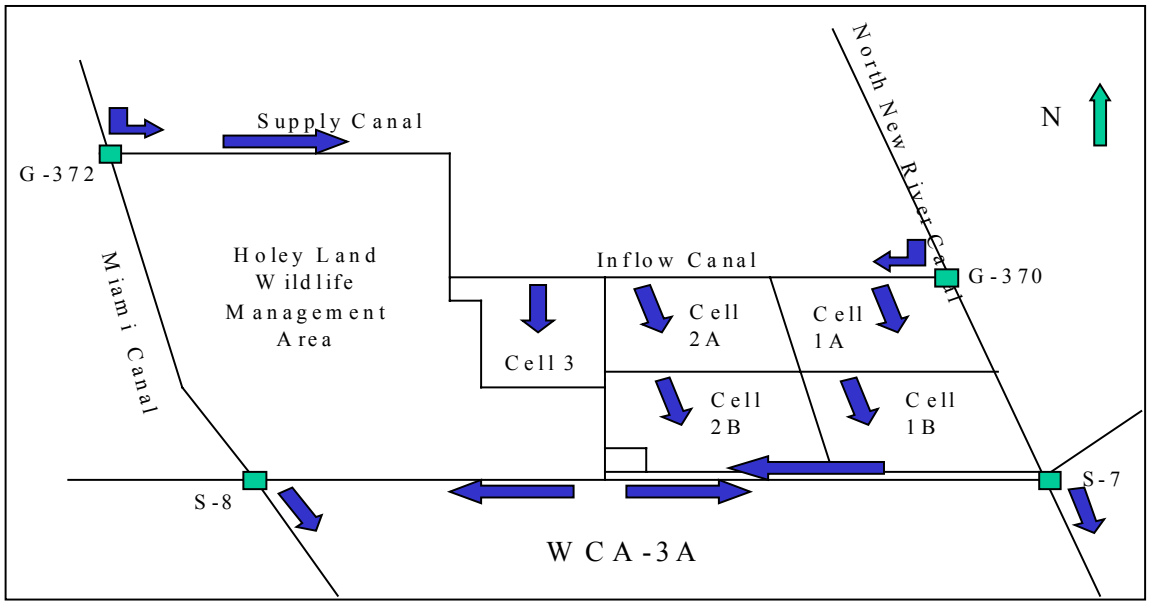



**Figure 4A-15.** Schematic of STA-3/4 (not to scale)

# STA-5

STA-5 contains approximately 4,110 acres of effective treatment area arranged in two parallel flow-ways. The northern flow-way (cells 1A and 1B) consists of approximately 2,055 acres of effective treatment area. The southern flow-way (cells 2A and 2B) consists of approximately 2,055 acres of effective treatment area. A schematic of STA-5 is presented in **Figure 4A-16.** Based on the 1979-88 period of flow and phosphorus data used during design, the STA should receive between 78,300 and 104,000 acre feet per year from the C-139 basin. Runoff that exceeds the hydraulic capacity of STA-5 will be diverted through G-406. Actual deliveries will vary based on hydrologic conditions in the basins.

Water enters the STA from the west and flows by gravity through the treatment area to the east. Treated water is collected and discharged to the Miami Canal, where the majority of the water moves south to the northwest corner of WCA-3A. A complete description of STA-5 is contained in Chapter 6 of the *2000 Everglades Consolidated Report.*

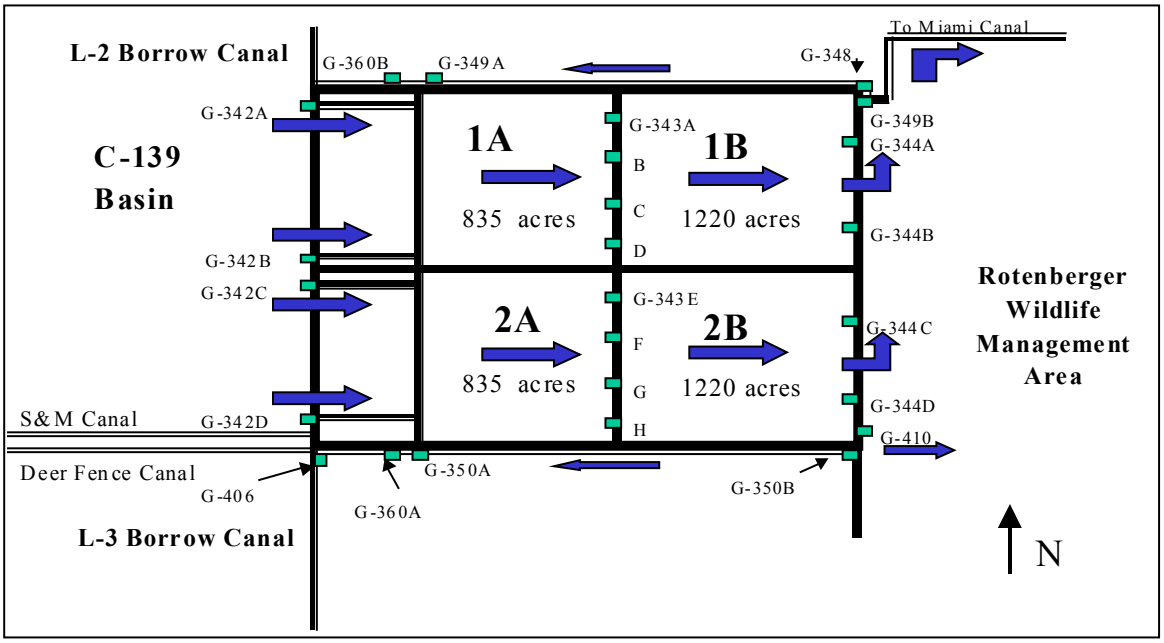
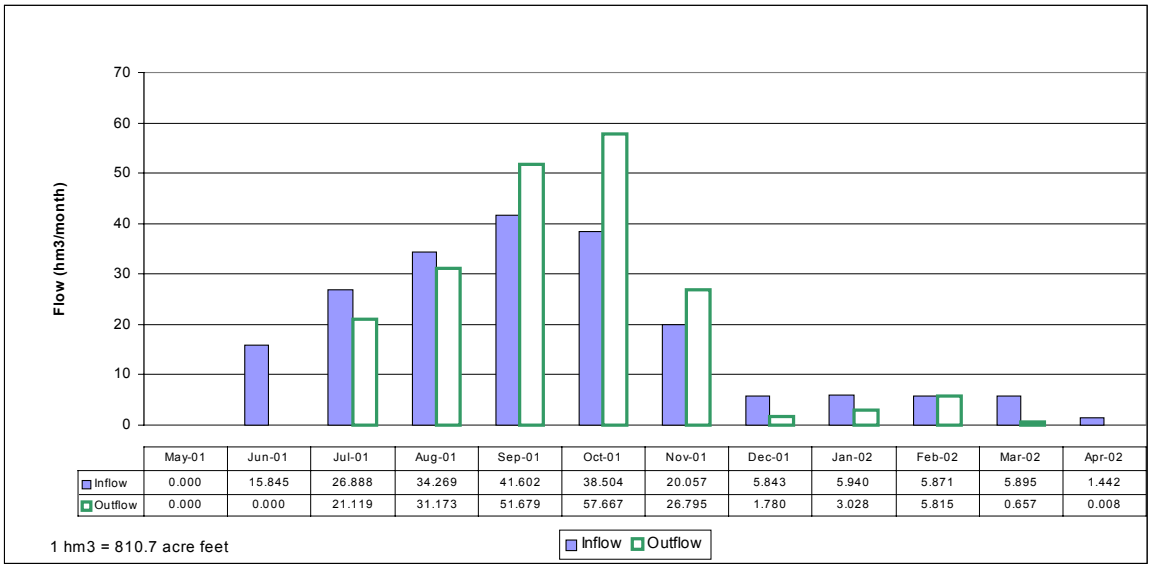



**Figure 4A-16.** Schematic of STA-5 (not to scale)

## STA-5 OPERATIONS

Operations at STA-5 over the past year were influenced significantly by the latter stages of the most severe drought ever recorded in South Florida. Three of the four treatment cells experienced a dryout period where water levels receded below the average ground surface elevation. One treatment cell, cell 1B, was kept at a minimum depth of six inches to protect a growing SAV community, but no supplemental water deliveries were needed to maintain that depth. When a normal wet-season rainfall pattern returned in June 2001, stormwater runoff from the C-139 basin resumed flow through STA-5. Structure operations followed normal wet-season guidelines as prescribed in the District's STA-5 operation plan until December 2001, when normal dry-season operations began. The STA remained in this water conservation mode for the remainder of the reporting period to protect vegetation in the treatment cells from drying out. Despite the lingering effects of the severe drought early in this reporting period, no serious impacts to any of the plant communities were discovered within STA-5.

During WY02, approximately 202 cubic hm (164,000 ac-ft) of water were captured and treated by STA-5, or about 160 percent of the anticipated average annual flow for the treatment area assumed during design. This surface inflow equates to an average hydraulic loading rate of 3.32 cm/d over the effective treatment area of the STA. As a result of the above-normal runoff from the C-139 basin, approximately 23,400 ac-ft of stormwater carrying approximately 12 metric tons of phosphorus was diverted around STA-5 through the G-406 structure. In the future, flows and loads diverted around STA-5 will be captured and treated in STA-6 Section 2, scheduled for completion in December 2006. A summary of monthly STA-5 flow is presented in **Figure 4A-17**.




| | May-01 | Jun-01 | Jul-01 | Aug-01 | Sep-01 | Oct-01 | Nov-01 | Dec-01 | Jan-02 | Feb-02 | Mar-02 | Apr-02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow | 0.000 | 15.845 | 26.888 | 34.269 | 41.602 | 38.504 | 20.057 | 5.843 | 5.940 | 5.871 | 5.895 | 1.442 |
| Outflow | 0.000 | 0.000 | 21.119 | 31.173 | 51.679 | 57.667 | 26.795 | 1.780 | 3.028 | 5.815 | 0.657 | 0.008 |

**Figure 4A-17.** Summary of WY02 flows for STA-5

## STA-5 VEGETATION

The composition of the plant communities within STA-5 is somewhat variable between the four treatment cells. Cell 1A is dominated by cattail (*Typha* sp.), but also contains significant amounts of primrose willow (*Ludwigia* sp.) and several panic grasses (*Panicum* sp.). The western quarter of cell 1A has a much higher average ground elevation than the remainder of the cell and

supports some notable upland plant species, such as wax myrtle (*Myrica cerifera*) and elderberry (*Sambuca canadensis*). Cell 1B is managed as a submerged aquatic vegetation (SAV) and periphyton cell; any emergent plants are eliminated using appropriate herbicides. Cell 2A is dominated by cattail and primrose willow, but contains a significant coverage of smartweed (*Polygonum* sp.) and mixed grasses. Cell 2B is also cattail-dominated, with isolated areas occasionally occupied by water lettuce (*Pistia stratiotes*).

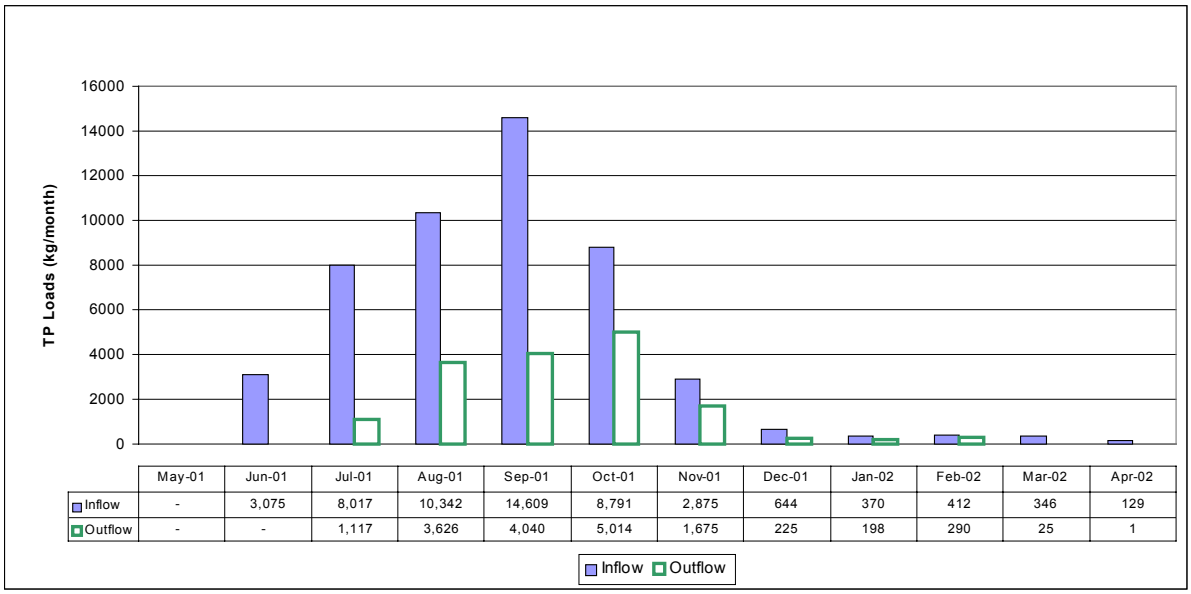
The EFA permit requires that the annual *Everglades Consolidated Report* include information regarding the application of herbicides to exclude and/or eliminate undesirable vegetation within the treatment cells. For this reporting period, the District applied a total of 491 gallons of 2-4,D, 56.1 gallons of Garlon 3A (trichlopyr), 149.5 gallons of AquaNeat (glyphosate), 44.3 gallons of Gly Pro Plus (glyphosate), 37.4 gallons of Roundup (glyphosate), 13.68 gallons of Arsenal (imazapyr), 50 gallons of Reward (Diquat dibromide) and 138 gallons of various adjuvants (surfactants used to help distribute the herbicide) to control nuisance vegetation in STA-5. Both aerial and ground-based spray equipment were used to apply these herbicides.

## STA-5 WATER QUALITY MONITORING

The data presented in this section demonstrate that STA-5 was in compliance with the EFA and NPDES operating permits for WY02, and that discharges do not pose any known danger to public health, safety, or welfare. The EFA permit states that STA-5 will remain in the stabilization phase of operation until STA-6 section 2 begins flow-through operations.

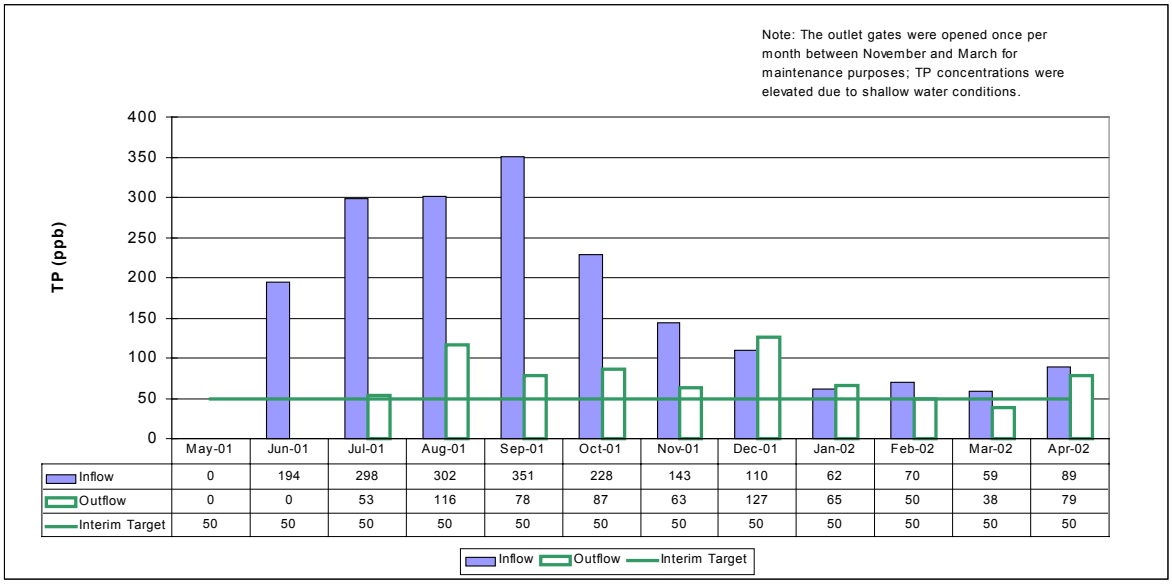
### Total Phosphorus

During WY02, STA-5 received 49.6 metric tons of phosphorus, equal to a nutrient-loading rate of 2.98 grams/sq m. This nutrient load was approximately 50 percent more than anticipated during the design of the treatment area. Despite the heavy loading, the treatment area performed well. Approximately 33.4 metric tons of TP were removed by STA-5 during WY02, equal to a removal rate of approximately 2.0 grams per square meter per year. This removal rate exceeded the design removal rate of approximately 1.5 grams per square meter per year. Monthly discharge TP concentrations were considerably lower than inflow concentrations, and between May 2001 and April 2002 STA-5 reduced discharge loads of total phosphorus by 67 percent compared to inflow loadings. A summary of monthly TP loads and flow-weighted mean TP concentrations is presented in **Figures 4A-18** and **4A-19**. The flow-weighted mean outflow TP concentration was 81 ppb, a 67-percent reduction from the inflow concentration of 245 ppb. The flow-weighted mean outflow concentration for WY02 is significantly lower than the 105 ppb reported last year and indicates that the treatment area continues to improve. While the outflow concentration is above the 50-ppb interim target, the STA is still in the stabilization phase and improved TP reduction is anticipated in the future. The geometric mean phosphorus concentration of the discharge was 79 ppb. Permit compliance requires that outflow TP concentrations be reported as moving 12-month flow-weighted mean values, and these are shown in **Figure 4A-20**. The moving 12-month flow-weighted mean TP outflow concentration for STA-5 decreased from 105 to 81 $\mu g\ L^{-1}$ over the course of WY2001. The 12-month flow-weighted average outflow TP concentration for STA-5 was 81 ppb during WY02. Since the 12-month average is above 50 ppb, the project remains in the stabilization phase. For informational purposes the geometric mean discharge phosphorus concentration for STA-5 was 83 ppb for Water Year 2002.




| | May-01 | Jun-01 | Jul-01 | Aug-01 | Sep-01 | Oct-01 | Nov-01 | Dec-01 | Jan-02 | Feb-02 | Mar-02 | Apr-02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow | - | 3,075 | 8,017 | 10,342 | 14,609 | 8,791 | 2,875 | 644 | 370 | 412 | 346 | 129 |
| Outflow | - | - | 1,117 | 3,626 | 4,040 | 5,014 | 1,675 | 225 | 198 | 290 | 25 | 1 |

**Figure 4A-18.** Summary of Water Year 2002 phosphorus loads for STA-5




| | May-01 | Jun-01 | Jul-01 | Aug-01 | Sep-01 | Oct-01 | Nov-01 | Dec-01 | Jan-02 | Feb-02 | Mar-02 | Apr-02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow | 0 | 194 | 298 | 302 | 351 | 228 | 143 | 110 | 62 | 70 | 59 | 89 |
| Outflow | 0 | 0 | 53 | 116 | 78 | 87 | 63 | 127 | 65 | 50 | 38 | 79 |
| Interim Target | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |

**Figure 4A-19.** Summary of Water Year 2002 phosphorus concentrations for STA-5

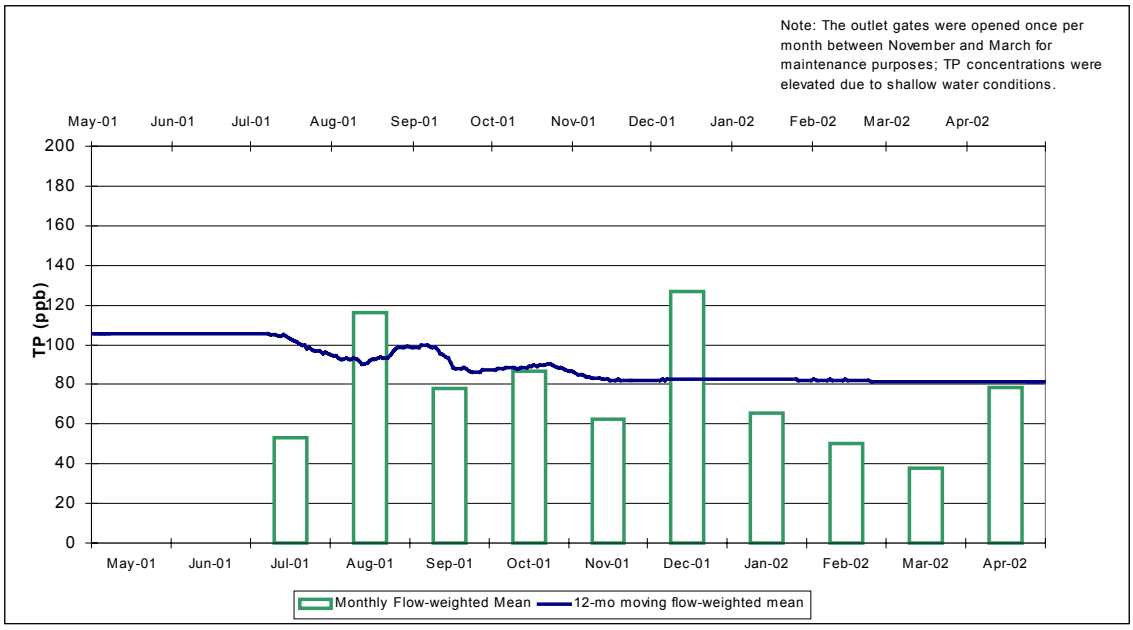



**Figure 4A-20.** Comparison of monthly to 12-month moving average phosphorus concentrations for WY02 for STA-5

## Non-phosphorus Parameters

The monitoring data for non-phosphorus parameters at STA-5 during this reporting period are presented in **Appendix 4A-8** and are summarized in **Table 4A-10**. Compliance with the EFA permit is determined based on the following three-part assessment:

1. If the annual average outflow concentration does not cause or contribute to violations of applicable Class III water quality standards, then STA-5 shall be deemed in compliance.
2. If the annual average concentration at the outflow causes or contributes to violations of applicable Class III water quality standards, but does not exceed or is equal to the annual average concentration at the inflow stations, then STA-5 shall be deemed in compliance.
3. If the annual average concentration at the outflow causes or contributes to violations of applicable Class III water quality standards and also exceeds the annual average concentration at the inflow station, then STA-5 shall be deemed out of compliance.

Discharges from STA-5 were determined to be in compliance by satisfying the initial test.

Additional requirements for dissolved oxygen are listed in Administrative Order AO-004-EV, and discussed below. Mercury monitoring results are also discussed in a proceeding section.

The District has included the following documentation to satisfy the remaining monitoring requirements of the EFA permit:

- The District has performed all sampling and analysis under the latest FDEP-approved CompQAP No. 870166G (June 1999).

- A signed copy of this statement, prepared by Maxine Cheesman, director of the Water Quality Monitoring Department, Division of Environmental Monitoring and Assessment, SFWMD, and who is the individual responsible for implementation of the sampling program during this period, is provided in **Appendix 4A-2**.

**Table 4A-10.** Summary of annual arithmetic averages and flow-weighted means for all parameters other than total phosphorus monitored in STA-5

| Parameter | Arithmetic Means | | | | | | | | Flow-Weighted Means | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Inflow | | | | Outflow | | | | Total Inflow | | Total Outflow | |
| | G342A | G342B | G342C | G342D | G344A | G344B | G344C | G344D | n | Conc. | n | Conc. |
| Temperature (°C) | 25.6 | 25.4 | 25.3 | 25.3 | 23.8 | 24.0 | 24.0 | 24.0 | -NA- | -NA- | -NA- | -NA- |
| Dissolved Oxygen (mg/L) | 4.8 | 4.7 | 4.7 | 4.9 | 4.0 | 3.6 | 2.5 | 2.8 | -NA- | -NA- | -NA- | -NA- |
| Specific Conductivity (µmhos/cm) | 548 | 558 | 578 | 578 | 600 | 599 | 689 | 671 | -NA- | -NA- | -NA- | -NA- |
| pH | 7.5 | 7.5 | 7.5 | 7.6 | 7.6 | 7.4 | 7.3 | 7.4 | -NA- | -NA- | -NA- | -NA- |
| Turbidity (NTU) | 3.4 | 3.3 | 3.0 | 4.4 | 1.8 | 1.7 | 2.0 | 2.2 | -NA- | -NA- | -NA- | -NA- |
| Total Dissolved Solids (mg/L) | 361 | 350 | 361 | 364 | 382 | 379 | 433 | 426 | 66 (104) | 306 | 40 (104) | 302 |
| Unionized Ammonia (mg/L) | 0.0010 | 0.0007 | 0.0008 | 0.0012 | 0.0023 | 0.0008 | 0.0005 | 0.0005 | 66 (104) | 0.0013 | 40 (103) | 0.0002 |
| Orthophosphate as P (mg/L) | 0.068 | 0.094 | 0.103 | 0.113 | 0.016 | 0.036 | 0.076 | 0.050 | 66 (104) | 0.155 | 40 (104) | 0.049 |
| Total Dissolved Phosphorus (mg/L) | 0.082 | 0.108 | 0.117 | 0.128 | 0.029 | 0.050 | 0.089 | 0.063 | 66 (104) | 0.171 | 40 (104) | 0.059 |
| Sulfate (mg/L) | 9.9 | 10.6 | 11.4 | 11.2 | 9.5 | 9.5 | 8.8 | 7.5 | 66 (104) | 10.0 | 40 (104) | 7.1 |
| Alkalinity (mg/L) | 184 | 191 | 197 | 207 | 160 | 168 | 232 | 228 | 66 (104) | 158 | 40 (104) | 155 |
| Dissolved Chloride (mg/L) | 56 | 53 | 53 | 49 | 86 | 79 | 72 | 68 | 66 (104) | 41 | 40 (104) | 45 |
| Total Nitrogen (mg/L) | 1.55 | 1.45 | 1.38 | 1.40 | 1.68 | 1.64 | 1.67 | 1.71 | 66 (104) | 1.62 | 40 (104) | 1.37 |
| Total Dissolved Nitrogen (mg/L) | 1.38 | 1.25 | 1.23 | 1.17 | 1.57 | 1.51 | 1.56 | 1.59 | 66 (104) | 1.47 | 40 (104) | 1.28 |
| Nitrate + Nitrite (mg/L) | 0.057 | 0.040 | 0.041 | 0.040 | 0.013 | 0.009 | 0.008 | 0.004 | 66 (104) | 0.059 | 40 (104) | 0.011 |
| Ametryn (µg/L) | 0.006 | 0.006 | 0.005 | 0.005 | 0.017 | 0.016 | 0.014 | 0.011 | 11 (16) | 0.010 | 6 (16) | 0.011 |
| Atrazin (µg/L) | 0.099 | 0.080 | 0.054 | 0.041 | 0.153 | 0.152 | 0.243 | 0.214 | 11 (16) | 0.046 | 6 (13) | 0.086 |

-NA- : Not Applicable
n: number of samples with flow (total number of samples)

**Table 4A-9.** Summary of annual arithmetic averages for all parameters other than total phosphorus monitored in STA-5.

| Parameter | Class III Standard | Sampling Results | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Inflows | | | | Outflows | | | |
| | | G342A | G342B | G342C | G342D | G344A | G344B | G344C | G344D |
| Temperature (°C) | N/A | 25.6 | 25.4 | 25.3 | 25.3 | 23.8 | 24.0 | 24.0 | 24.0 |
| Dissolved Oxygen (mg/L) | Greater than or equal to 5.0 mg/L | 4.8 | 4.7 | 4.7 | 4.9 | 4.0 | 3.6 | 2.5 | 2.8 |
| Specific Conductivity (µmhos/cm) | Not greater than 50% of background or greater than 1,275 | 548 | 558 | 578 | 578 | 600 | 599 | 689 | 671 |
| pH | Not less than 6.0 and not greater than 8.5 | 7.5 | 7.5 | 7.5 | 7.6 | 7.6 | 7.4 | 7.3 | 7.4 |
| Turbidity (NTU) | Less than or equal to 29 NTU above background conditions | 3.4 | 3.3 | 3.0 | 4.4 | 1.8 | 1.7 | 2.0 | 2.2 |
| Total Dissolved Solids (mg/L) | N/A | 361 | 350 | 361 | 364 | 382 | 379 | 433 | 426 |
| Unionized Ammonia (mg/L) | Less than or equal to 0.02 mg/L | 0.001 | 0.001 | 0.001 | 0.001 | 0.002 | 0.001 | 0.000 | 0.000 |
| Orthophosphate as P (mg/L) | N/A | 0.068 | 0.094 | 0.103 | 0.113 | 0.016 | 0.036 | 0.076 | 0.050 |
| Total Dissolved Phosphorus (mg/L) | N/A | 0.082 | 0.108 | 0.117 | 0.128 | 0.029 | 0.050 | 0.089 | 0.063 |
| Sulfate (mg/L) | N/A | 9.9 | 10.6 | 11.4 | 11.2 | 9.5 | 9.5 | 8.8 | 7.5 |
| Alkalinity (mg/L) | Not less than 20 mg/L | 184 | 191 | 197 | 207 | 160 | 168 | 232 | 228 |
| Dissolved Chloride (mg/L) | N/A | 56 | 53 | 53 | 49 | 86 | 79 | 72 | 68 |
| Total Nitrogen (mg/L) | N/A | 1.55 | 1.45 | 1.38 | 1.40 | 1.68 | 1.64 | 1.67 | 1.71 |
| Total Dissolved Nitrogen (mg/L) | N/A | 1.38 | 1.25 | 1.23 | 1.17 | 1.57 | 1.51 | 1.56 | 1.59 |
| Nitrate + Nitrite (mg/L) | N/A | 0.057 | 0.040 | 0.041 | 0.040 | 0.013 | 0.009 | 0.008 | 0.004 |
| Ametryn (µg/L) | N/A | 0.006 | 0.006 | 0.041 | 0.040 | 0.013 | 0.009 | 0.008 | 0.004 |
| Atrazin (µg/L) | N/A | 0.099 | 0.080 | 0.041 | 0.040 | 0.013 | 0.009 | 0.008 | 0.004 |

# DISSOLVED OXYGEN MONITORING

## INTRODUCTION

STA-5 Administrative Order No. AO-004-EV in Exhibit C of Permit No. 0131842, February 29, 2000, specifies the same dissolved oxygen monitoring requirements as STA-1W (page 4A-1 and 2 of this chapter).

The District developed the following plan to comply with the DO requirements of the administrative orders for STA-5 by measuring DO concentrations with Hydrolab™, DataSonde®, or MiniSonde® probes at 30-minute intervals and quarterly for four consecutive days at the following locations:

- Upstream of the four inflow structures G-342A-D
- In the discharge canal near structures G-344A and G-344D to provide representative data whether the discharge is to the Miami Canal, the Rotenberger Tract through pump station G-410, or to both sites simultaneously
- Background conditions in the Miami Canal are measured on the west bank about 100 meters upstream of the confluence of the Miami Canal and the STA-5 discharge canal
- Effects of STA-5 discharges to the Miami Canal are measured on the west bank about 100 meters downstream of the confluence of the Miami Canal and the STA-5 discharge canal
- Effects of STA-5 discharges to the Rotenberger Tract are measured at sites along the N and S transects within the Rotenberger Tract (**Figure 4A-21**).

Diel oxygen measurement dates and sites for Water Year 2002 are provided in **Table 4A-11**.

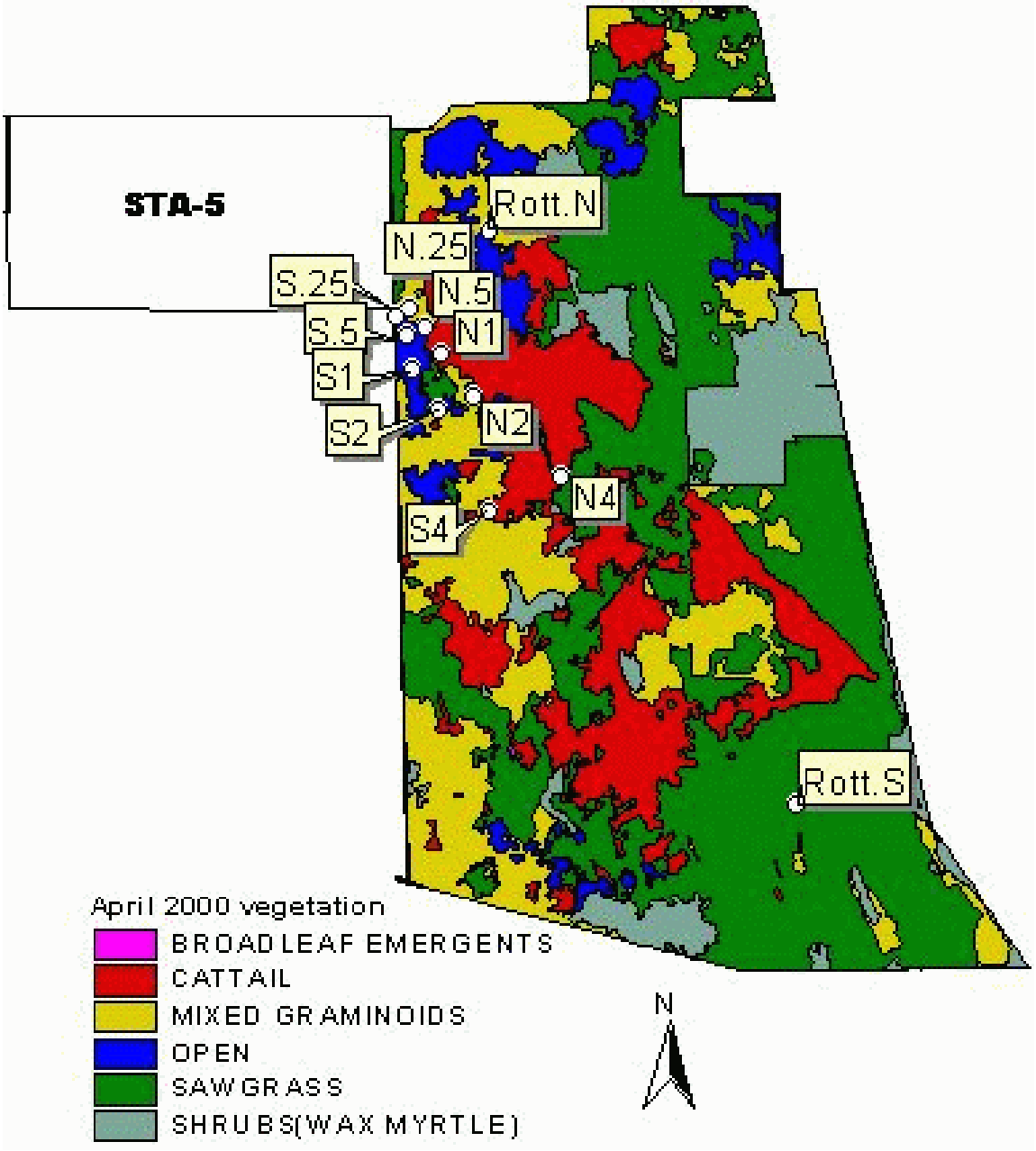



**Figure 4A- 21.** Dissolved oxygen monitoring sites in Rotenberger Tract

**Table 4A-11.** Deployment dates for diel oxygen measurement at STA-5 structures, sites in the Miami Canal, and Rotenberger Tract marsh sites

| Event Dates | | Structures | | Miami Canal Sites | | Sites Monitored in Rotenberger Tract |
|---|---|---|---|---|---|---|
| Start | End | Outflow | | | | |
| 05/21/2001 | 05/24/2001 | G344A | G344D | NMC | SMC | ---------- |
| 09/20/2001 | 09/26/2001 | G344A | G344D | NMC | SMC | N.25, N1, N4, S.25, S1, S4 |
| 11/07/2001 | 11/13/2001 | G344A | G344D | NMC | SMC | N.25, N1, N4, S.25, S1, S4 |
| 03/20/2002 | 03/27/2002 | G344A | G344D | NMC | SMC | ---------- |

### *Comparison of Dissolved Oxygen in STA-5 Discharges With Dissolved Oxygen at Miami Canal and Rotenberger Tract Marsh Sites*

Comparisons of DO in STA-5 discharges with DO in the Miami Canal and at Rotenberger Tract marsh transect sites provide an indication of whether the discharge is affecting the canal and marsh DO concentrations or the diel oxygen cycle.

The summary statistics for STA-5 discharges and the downstream sites are presented in **Table 4A-12**. The complete data sets collected during Water Year 2002 are presented in **Appendix 4A-9**. Examination of this table shows that median, mean and maximum DO concentrations in discharges from G-344A are greater than those from G-344D. The notched box and whisker plots for these sites show that G-344A has a significantly higher median DO concentration (**Figure 4A-22**). The north Miami Canal site median and mean DO concentrations are slightly higher than the south Miami Canal values, but the notched box and whisker plots show they are not statistically different (**Figure 4A-22**). This indicates that the combined STA discharge entering the Miami Canal did not have a measurable effect on Miami Canal dissolved oxygen concentrations.

**Table 4A-12.** Statistical summary of diel dissolved oxygen at the outflow stations from STA-5, stations in the Miami Canal and marsh stations in the Rotenberger Tract during four deployment periods

| Location | Station | Number of Measurements | Mean | Minimum | Median | Maximum | Standard Deviation |
|---|---|---|---|---|---|---|---|
| **Outflow** | G344A | 1,062 | 3.57 | 0.37 | 3.78 | 8.64 | 1.99 |
| | G344D | 1,065 | 2.17 | 0.70 | 2.16 | 4.80 | 0.88 |
| **Miami Canal** | NMC | 1,067 | 3.80 | 0.73 | 3.48 | 8.56 | 1.96 |
| | SMC | 1,066 | 3.73 | 0.56 | 3.39 | 8.81 | 1.82 |
| **Transect N** | N.25 | 510 | 1.76 | 0.24 | 1.64 | 4.84 | 1.03 |
| | N1 | 512 | 1.52 | 0.16 | 1.39 | 4.53 | 0.90 |
| | N4 | 512 | 2.30 | 0.40 | 1.90 | 6.70 | 1.34 |
| **Transect S** | S.25 | 512 | 2.55 | 0.29 | 2.37 | 6.17 | 1.44 |
| | S1 | 511 | 2.80 | 0.18 | 2.42 | 7.33 | 1.87 |
| | S4 | 512 | 2.24 | 0.48 | 2.00 | 6.77 | 1.33 |

See **Appendix 4-4**, **Table 3** for statistical summaries by event and diel parameter

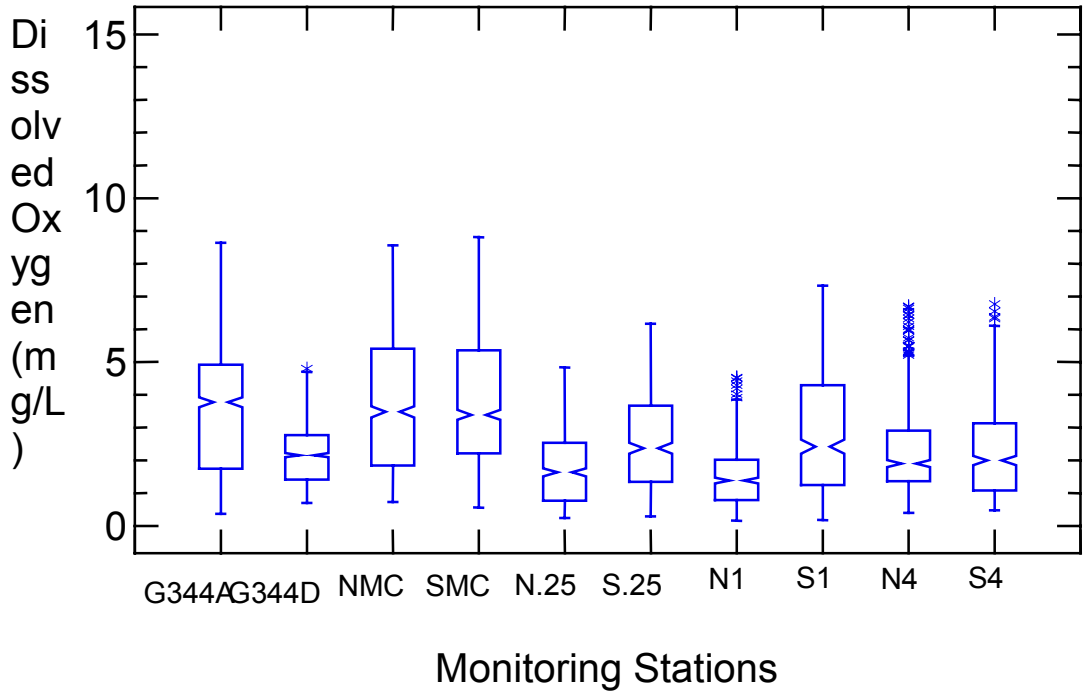



**Figure 4A- 22**. Notched-box and whisker plots of diel dissolved oxygen measurements at the STA-5 outflow stations (G344A and G344D), at sites in the Miami Canal (NMC and SMC), and along transect sites in the Rotenberger Tract during four monitoring periods The notch on a box plot represents the 95-percent confidence interval about the median, which is represented by the narrowest part of the notch. The top and bottom of the box represent the 75th and 25th percentiles, respectively. The whiskers represent the highest and lowest data values that are within two standard deviations of the median. Values above and below the whiskers are greater than two standard deviations from the median. Notches that do not overlap indicate that the data represented by the boxes being compared are significantly different at the 95-percent confidence level

Comparisons between the median DO concentrations in the discharges with marsh sites along the Rotenberger north and south transects show that N25, N1, N4, and S4 are lower. S25 and S1 are greater than G-344D, but less than G-344A. Comparison of median DO concentrations between the corresponding sites on the north and south transects shows that N25 and N1 are less than S25 and S1 values. The N4 and S4 data are essentially the same.

Comparison between the notched box and whisker plots for the median DO in the discharges with those of transect sites N.25 and N1 shows that the discharges are significantly greater than these transect sites. In contrast, the median DO concentrations at sites S.25, S1, S4, and N4 are not significantly different from the G-344D median concentration but are significantly less than the G-344A median concentration.

Based on the data presented, it does not appear that STA-5 discharges are having any negative effect on dissolved oxygen conditions in the Miami Canal or along the Rotenberger Tract transects.

### Mercury

The results of mercury compliance monitoring for routine operation are summarized in **Appendix 4A-4** of this chapter. During Water Year 2002, there were no violations of the Florida Class III numerical water quality standard of 12 ng/L unfiltered total mercury (THg). As such, the Everglades Construction Project has met one of the requirements of the operating permits.

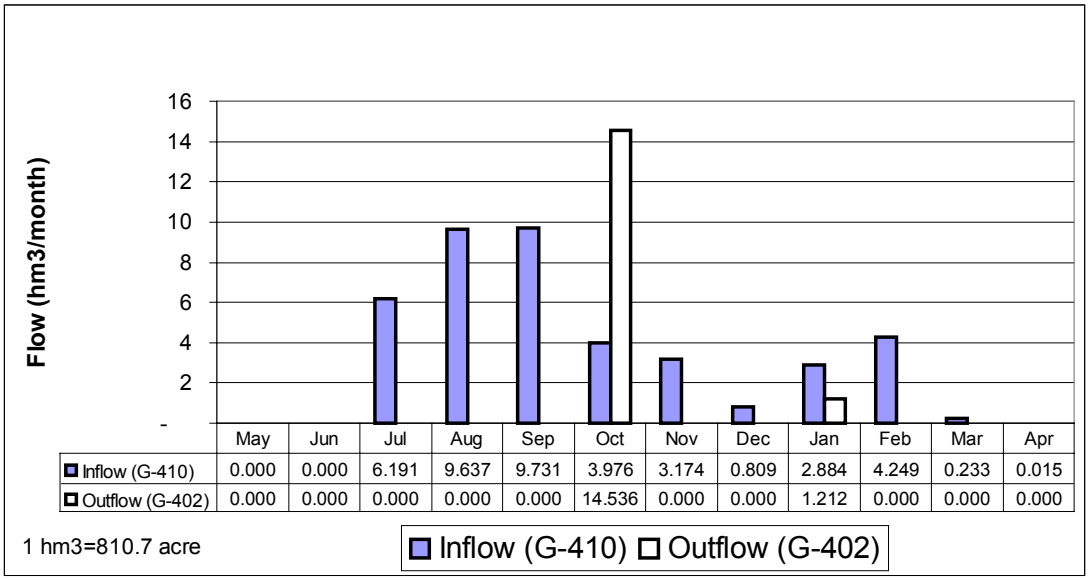
Concentrations of THg and MeHg in sediment cores collected from STA-5 in 2001 remained at background levels observed in cores collected in 1998 and continued to be within the expected range for Everglades soils. During the reporting year, THg and MeHg concentrations in surface water generally exhibited a reduction across STA-5. Further, levels of Hg in mosquitofish from the interior marshes of STA-5 declined from peak levels observed during the second semiannual collection in 2000 and contained roughly 50 percent less Hg than fish from either the inflows or outflows; levels of Hg were generally similar in mosquitofish at inflow and outflows of STA-5. Alternatively, concerns were raised by the observation that Hg concentrations were greater in sunfish from the discharge canal and the interior compared to sunfish from the supply canal. Further, while concentrations of Hg declined over the last three years in sunfish inhabiting the supply canal, mercury levels increased in fish from the interior and the discharge canal in 2000 and remained elevated in Water Year 2002 relative to 1999. Likewise, there is some evidence to suggest that levels of Hg have increased slightly in largemouth bass in the discharge canal during the monitoring period. Finally, while temporal trends cannot be evaluated for bass inhabiting the interior marshes of STA 5 (due to age distribution of collected fishes), the expected mean concentration of Hg in three-year-old interior bass reached 801 ±147 ng/g in 2001, which exceeds the state's limited consumption advisory for human health of 500 ng/g wet weight muscle (0.5 mg/Kg or 0.5 ppm). For perspective, the entire Everglades still remains under Department of Health advisories, which recommends no, or limited, consumption of select fish species due to high mercury levels in their flesh.

## ROTENBERGER WILDLIFE MANAGEMENT AREA

The Rotenberger Hydropattern Restoration Project is a component of the Everglades Construction Project. The goal of the project is to restore a more natural hydroperiod and thereby reverse the ecosystem degradation within the Rotenberger Wildlife Management Area caused by drought and seasonal fires, soil oxidation and compaction, and the release of ambient nutrients from soils. The anticipated benefits include the preservation of coverage of the remaining desired vegetative species, replacement of undesirable vegetation species with desirable wetland vegetation, and the initiation of the process of peat formation. The FDEP completed acquisition of all the remaining private lands within Rotenberger and the District completed construction in October 2000. Project features (see Figures 4A-16 and 4A-21) include a 240-cfs electric powered pump station (G-410) to withdraw treated water from the STA-5 Discharge Canal for establishing more natural hydroperiod within Rotenberger. This pump station distribute water through a 3½-mile long spreader canal located parallel to the west perimeter levee of Rotenberger. Discharges out of Rotenberger go into the Miami Canal through four gated culverts (G-402D) along the eastern boundary of Rotenberger. There is also a quarter-mile long collection canal upstream of each outlet structure.

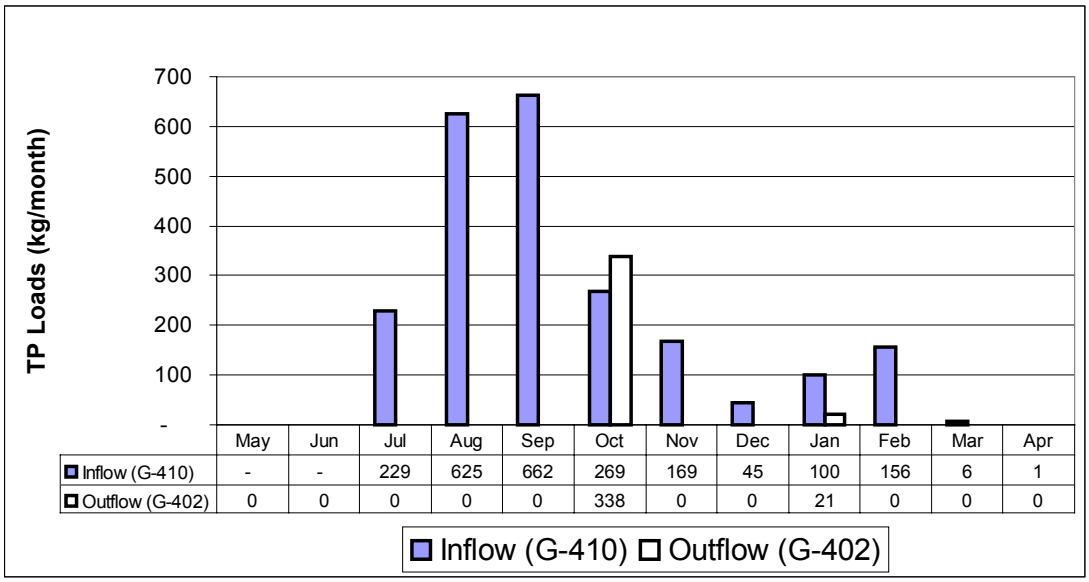
The FDEP issued a modification to the STA-5 Everglades Forever Act permit for the project in October 2000. The permit establishes a phase approach to restoration and recognizes an inter-agency group, including representatives from the FDEP, Florida Fish and Wildlife Conservation Commission, the U.S. Army Corps of Engineers, the Friends of the Everglades and the District. The permit requires the inter-agency group to periodically evaluate the progress the project is making towards achieving its restoration goals. The first part of this phased approach calls for an interim operational period, which will last for two years from the first date of discharge from the G-410 pumping station (July 2001). After this interim period the inter-agency group shall evaluate the benefits and progress toward ultimate goals and then decide to continue interim operations or modify operations if determined to be necessary to achieve restoration goals. The interim phase of operations utilizes the G-410 pumps only when STA-5 is in a discharge mode and when water levels within the tract are below the daily regulation schedule. This schedule was based on the 31-year stages predicted by the Natural Systems Model. On July 18, 2002 the interagency group convened to discuss the first year's interim operation and progress being made towards achieving the restoration goals of the project. The consensus of the inter-agency group was that favorable progress being made towards restoration, as desirable vegetation species had replaced the prior undesirable species, and water column phosphorus levels had decreased below pre-project levels.

For WY02, approximately 41 cubic hectometers (33,000 acre feet) were directed into Rotenberger through G-410, while approximately 16 cubic hectometers (13,000 acre feet) were discharged to the Miami Canal from the outlet structures (see **Figure 4A-23**). The flow-weighted mean inflow phosphorus concentration was 55 ppb, yielding a total phosphorus inflow load of approximately 2,300 kg (see **Figure 4A-24** and **4A-25**). As the treatment system in STA-5 stabilizes, phosphorous levels entering Rotenberger are anticipated to decrease. Phosphorus concentrations leaving Rotenberger averaged 23 ppb.



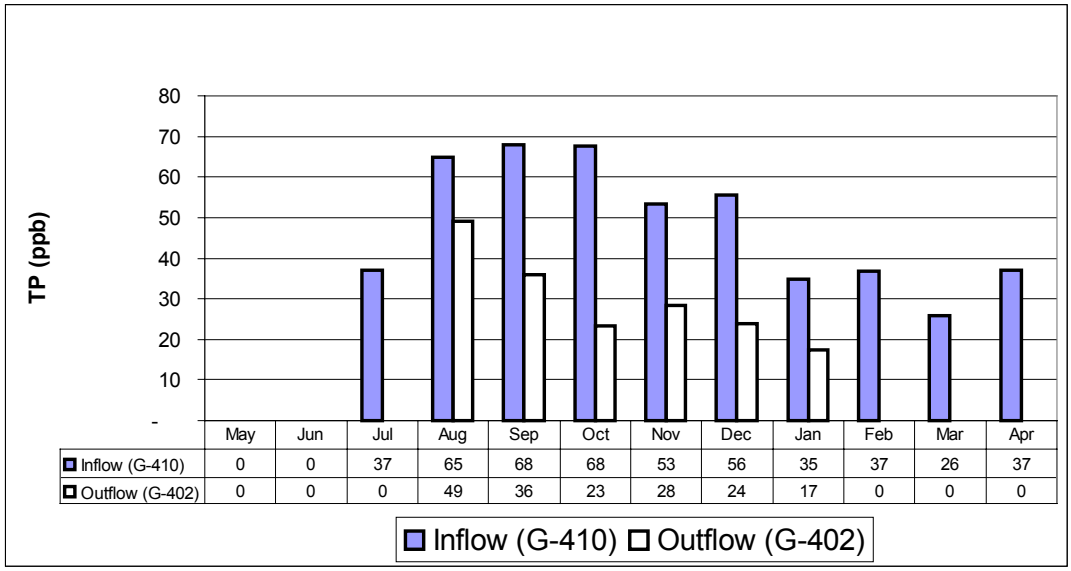

| | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow (G-410) | 0.000 | 0.000 | 6.191 | 9.637 | 9.731 | 3.976 | 3.174 | 0.809 | 2.884 | 4.249 | 0.233 | 0.015 |
| Outflow (G-402) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 14.536 | 0.000 | 0.000 | 1.212 | 0.000 | 0.000 | 0.000 |

**Figure 4A-23.** Summary of Water Year 2002 flows for the Rotenberger Wildlife Management Area




| | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow (G-410) | - | - | 229 | 625 | 662 | 269 | 169 | 45 | 100 | 156 | 6 | 1 |
| Outflow (G-402) | 0 | 0 | 0 | 0 | 0 | 338 | 0 | 0 | 21 | 0 | 0 | 0 |

**Figure 4A-24.** Summary of Water Year 2002 phosphorus loads for the Rotenberger Wildlife Management Area




| | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | Apr |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow (G-410) | 0 | 0 | 37 | 65 | 68 | 68 | 53 | 56 | 35 | 37 | 26 | 37 |
| Outflow (G-402) | 0 | 0 | 0 | 49 | 36 | 23 | 28 | 24 | 17 | 0 | 0 | 0 |

**Figure 4A-25.** Summary of Water Year 2002 phosphorus concentrations for the Rotenberger Wildlife Management Area

# STA-6, SECTION 1 (STA-6)

STA-6 contains approximately 870 acres of effective treatment area, arranged in two parallel flow-ways. The northern flow-way (Cell 5) consists of approximately 625 acres of effective treatment area. The southern flow-way (Cell 3) consists of approximately 245 acres of effective treatment area. A schematic of STA-6 is presented in **Figure 4A-26.** Based on the 1979-88 period of flow and phosphorus data used during design, the STA should receive approximately 16,000 acre feet from the EAA basin. Actual deliveries will vary based on hydrologic conditions in the basins.

Water enters the STA from the G-600 pumping station (operated by U.S. Sugar Corporation), travels southeast in the supply canal. Water enters the treatment cells through three broad-crested weirs (G-601, G-602, and G-603) and flows by gravity east through the treatment cells. Treated water is collected in the discharge canal and discharges to the L-4 borrow canal, where the majority moves east to the northwest corner of WCA-3A.

STA-6 section 2 will add approximately 1,400 acre of additional treatment area to the STA-5/STA-6 system. This expansion will allow for the capture and treatment of any C-139 basin runoff that exceeds the hydraulic capacity of STA-5 as well as runoff from the C-139 annex, located just west of the L-3 borrow canal. STA-6 section 2 is scheduled to be completed by December 31, 2006.

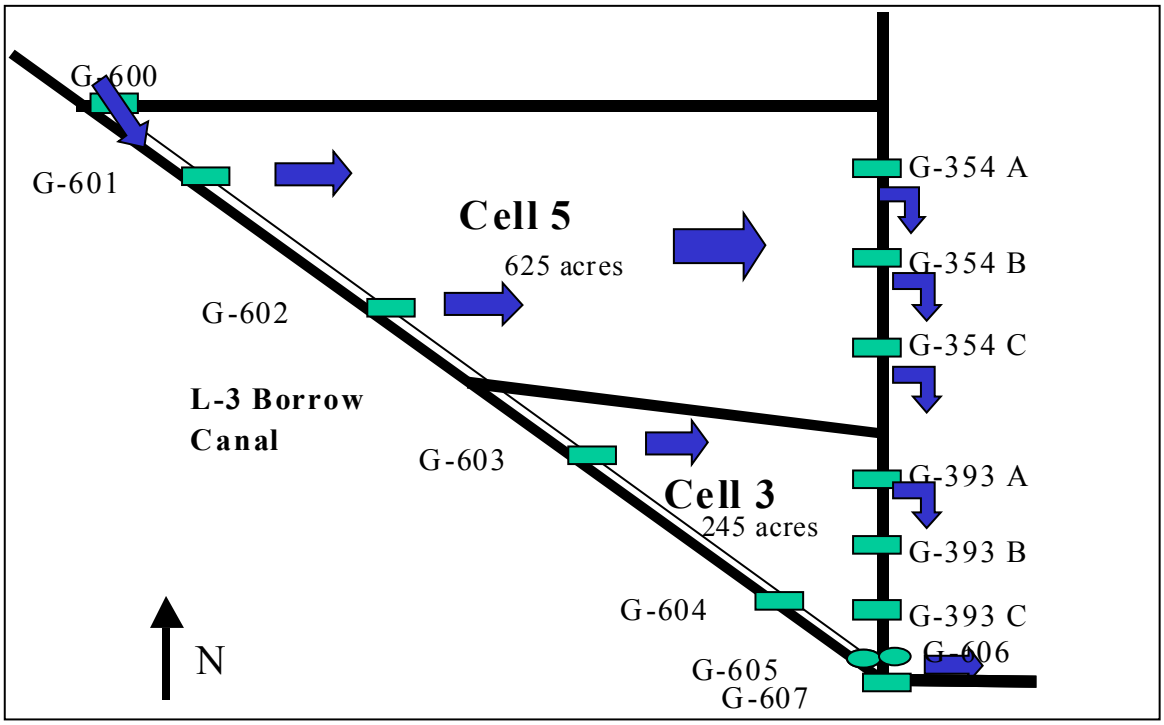
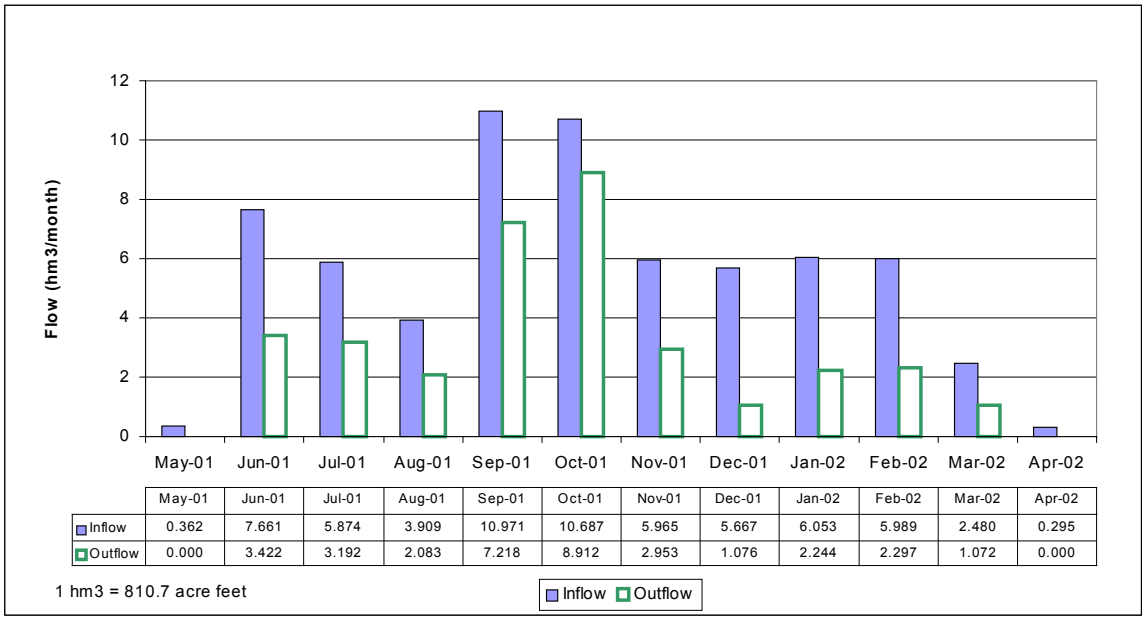



**Figure 4A-26.** Schematic of STA-6 (not to scale)

## STA-6 OPERATIONS

Operations at STA-6 during this reporting period were influenced significantly by the latter stages of a severe drought in south Florida. During WY02, STA-6 experienced two separate dry-out events. The first event, a result of the 2001 drought, occurred in May 2001 while the second dry-out occurred as a result of normal dry season conditions in April 2002. No emergency water deliveries were required at STA-6 because the plant communities are somewhat drought resistant. Stormwater flow-through operations at STA-6 during the wet season followed normal patterns as described in the Operation Plan and were controlled mainly by United States Sugar Corporation's G-600 pumping station.

During WY2002 approximately 65.9 cubic hm (53,437 acre feet) of water was captured and treated in STA-6, equating to a hydraulic load of 5.1 cm/day. Due to seepage losses and evapotranspiration, the net volume of treated water discharged from STA-6 during WY02 was 34.5 cubic hectometers (27,945 acre feet). A summary of monthly flow is presented in **Figure 4A-27**.




| | May-01 | Jun-01 | Jul-01 | Aug-01 | Sep-01 | Oct-01 | Nov-01 | Dec-01 | Jan-02 | Feb-02 | Mar-02 | Apr-02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow | 0.362 | 7.661 | 5.874 | 3.909 | 10.971 | 10.687 | 5.965 | 5.667 | 6.053 | 5.989 | 2.480 | 0.295 |
| Outflow | 0.000 | 3.422 | 3.192 | 2.083 | 7.218 | 8.912 | 2.953 | 1.076 | 2.244 | 2.297 | 1.072 | 0.000 |

**Figure 4A-27.** Summary of Water Year 2002 flows for STA-6

## STA-6 VEGETATION

Because of its past and current hydroperiod, the plant community in STA-6 is composed predominantly of drought resistant vegetation. The composition of the plant communities within STA-6 is somewhat variable between the two treatment cells. Cell 3 is dominated primarily by sawgrass (*Cladium jamaicense*) but also contains significant amounts of primrose willow (*Ludwigia* sp.) and arrowhead (*Sagittaria* sp). Cell 5 is dominated by panic grasses (*Panicum* sp.), but the eastern portion of the cell contains some seasonal periphyton communities. Cell 5 also contains isolated areas of cattail (*Typha* sp.) and smartweed (*Polygonum* sp.) and SAV.

Specific Condition 13(b) of the operating permit requires that the annual report include information regarding the application of herbicides to exclude and/or eliminate undesirable vegetation in the treatment cells. For this reporting period, the District applied a total of 26.5 gallons of

Garlon 3A (trichlopyr), 13.33 gallons of AquaNeat, 11.25 gallons of Gly Pro Plus (glyphosate), 18.62 gallons of Roundup (glyphosate), 4.31 gallons of Arsenal (imazapyr), and 4 gallons of various adjuvants (surfactants used to help distribute the herbicide) to control Brazilian pepper growing on the project levees. Ground-based spray equipment only was used to apply the herbicide.

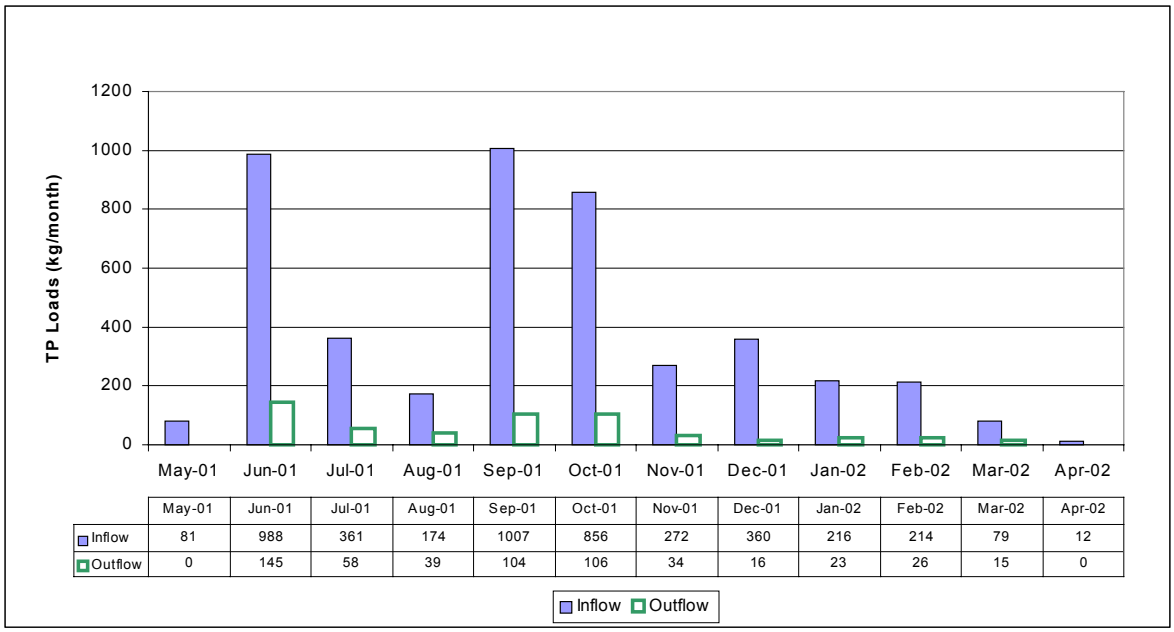
## STA-6, SECTION 1 WATER QUALITY MONITORING

The District initiated a water quality monitoring program in STA-6 in December 1997 for the purpose of demonstrating compliance with the above mentioned conditions of the operating permit. Presently, STA-6 is in a post-stabilization phase. STA-6 discharges do not pose any known danger to public health, safety or welfare. Compliance with specific conditions 7(a)(i) and 7(a)(ii) was achieved.

### Total Phosphorus

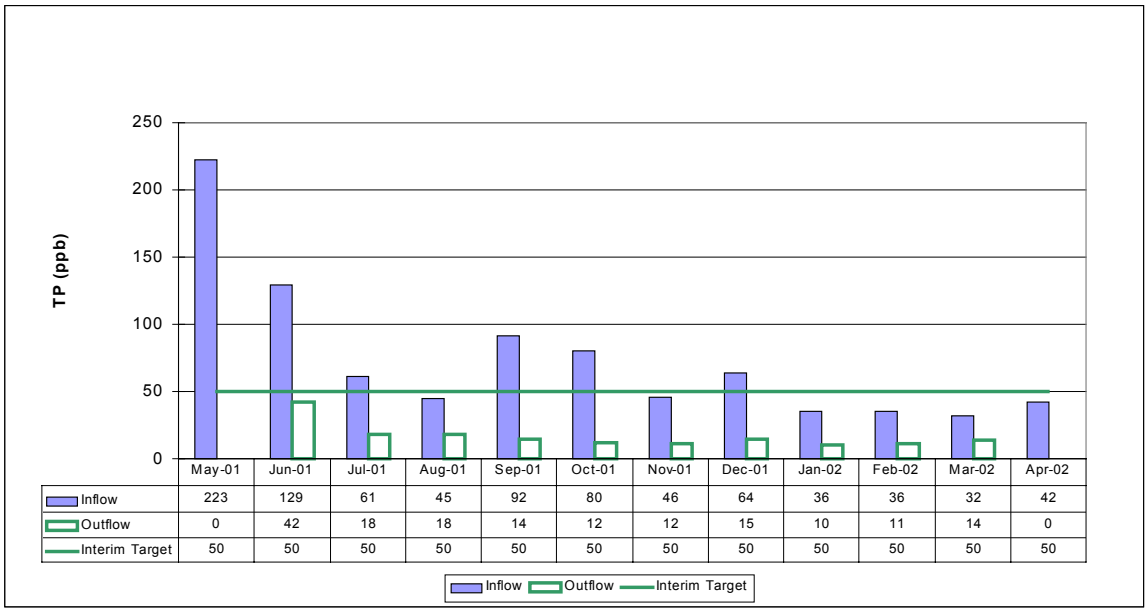
STA-6 continues to achieve its interim discharge goal of less than 50 ppb for TP. During WY2002, the STA received 4.6 metric tons of phosphorus, equating to a nutrient loading rate of 1.3 grams/square meter. Approximately 4 metric tons of TP were removed by STA-6 during WY2002. Between May 2001 and April 2002, STA-6 experienced an 88 percent load reduction in total phosphorus (**Figure 4A-28**). Furthermore, monthly discharge concentrations were considerably lower than inflow concentrations (**Figure 4A-29**). The flow-weighted mean outflow concentration was 16 ppb, a 77 percentage reduction from the inflow concentration of 70 ppb. For informational purposes, the geometric mean phosphorus concentration of the discharge was 17 ppb.

The EFA permit requires that the flow-weighted average annual outflow concentration remains below 76 ppb, and STA-6 exhibited an annual value of 16 ppb during WY2002. The moving 12-month flow-weighted average decreased from 30 ppb to 16 ppb during the course of WY02 (see **Figure 4A-30**).




| | May-01 | Jun-01 | Jul-01 | Aug-01 | Sep-01 | Oct-01 | Nov-01 | Dec-01 | Jan-02 | Feb-02 | Mar-02 | Apr-02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow | 81 | 988 | 361 | 174 | 1007 | 856 | 272 | 360 | 216 | 214 | 79 | 12 |
| Outflow | 0 | 145 | 58 | 39 | 104 | 106 | 34 | 16 | 23 | 26 | 15 | 0 |

**Figure 4A-28.** Summary of Water Year 2002 phosphorus loads for STA-6




| | May-01 | Jun-01 | Jul-01 | Aug-01 | Sep-01 | Oct-01 | Nov-01 | Dec-01 | Jan-02 | Feb-02 | Mar-02 | Apr-02 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Inflow | 223 | 129 | 61 | 45 | 92 | 80 | 46 | 64 | 36 | 36 | 32 | 42 |
| Outflow | 0 | 42 | 18 | 18 | 14 | 12 | 12 | 15 | 10 | 11 | 14 | 0 |
| Interim Target | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |

**Figure 4A-29.** Summary of Water Year 2002 phosphorus concentrations for STA-6

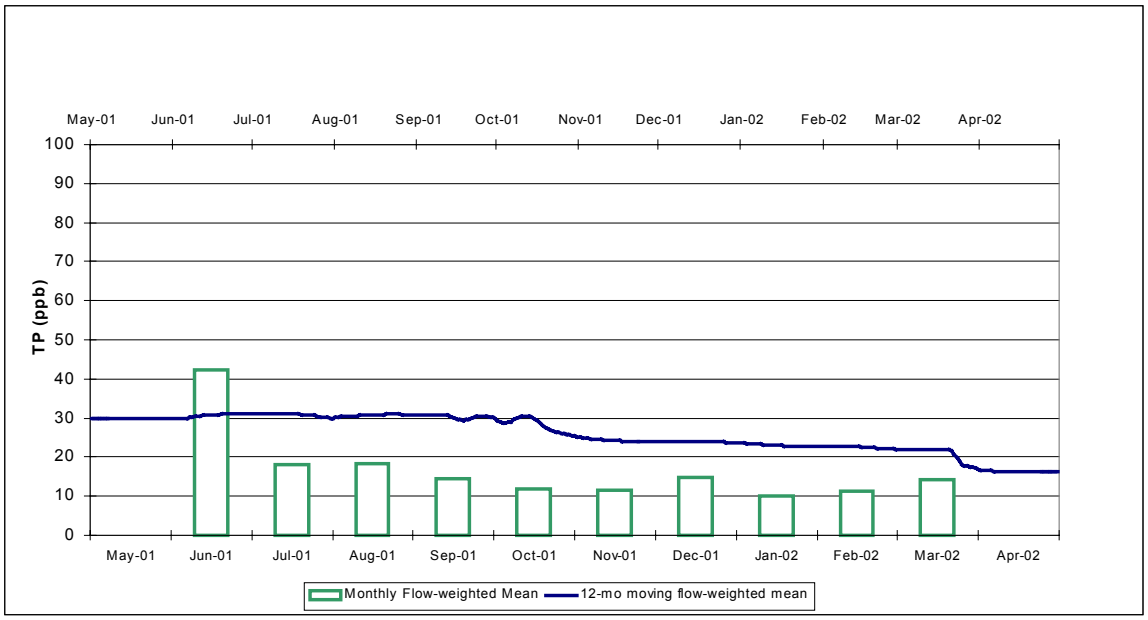



**Figure 4A-30.** Comparison of monthly with 12-month moving average phosphorus concentrations for Water Year 2002 for STA-6

## Non-phosphorus Parameters

The monitoring data for non-phosphorus parameters at STA-6 during this reporting period are presented in **Appendix 4A-10** and summarized in **Table 4A-13**. Compliance with the EFA permit is determined based on the following three-part assessment:

If the annual average outflow concentration does not cause or contribute to violations of applicable class III water quality standards, then STA-6 shall be deemed in compliance.

If the annual average concentration at the outflow causes or contributes to violations of applicable class III water quality standards, but does not exceed, or is equal to, the annual average concentration at the inflow stations, then STA-6 shall be deemed in compliance.

If the annual average concentration at the outflow causes or contributes to violations of applicable class III water quality standards, and also exceeds the annual average concentration at the inflow station, then STA-6 shall be deemed out of compliance.

Discharges from STA-6 were determined to be in compliance by satisfying the initial test (see **Table 4A-13**). Dissolved potassium and ametryn were slightly higher in the outflow than inflow concentrations, however, since these parameters have no applicable numeric state water quality standards, STA-6 is deemed to be in full compliance with the permit.

**Table 4A-13.** Summary of annual arithmetic averages and flow-weighted means for all parameters other than total phosphorus monitored in STA-6

| Parameter | Arithmatic Means | | | Flow-Weighted Means | | | |
|---|---|---|---|---|---|---|---|
| | Inflow | Outflow | | Total Inflow | | Total Outflow | |
| | G600 | G354C | G393B | n | Conc. | n | Conc. |
| Temperature (°C) | 25.3 | 24.4 | 22.5 | -NA- | -NA- | -NA- | -NA- |
| Dissolved Oxygen (mg/L) | 3.1 | 3.3 | 1.5 | -NA- | -NA- | -NA- | -NA- |
| Specific Conductivity (µmhos/cm) | 849 | 747 | 775 | -NA- | -NA- | -NA- | -NA- |
| pH | 7.3 | 7.5 | 7.2 | -NA- | -NA- | -NA- | -NA- |
| Turbidity (NTU) | 3.6 | 1.1 | 0.8 | -NA- | -NA- | -NA- | -NA- |
| Color (PCU) | 75 | 80 | 86 | -NA- | -NA- | -NA- | -NA- |
| Total Suspended Solids (mg/L) | 7.5 | 1.6 | 0.8 | 18 (27) | 7.6 | 36 (52) | 0.8 |
| Unionized Ammonia (mg/L) | 0.0014 | 0.0034 | 0.0002 | 18 (27) | 0.0020 | 36 (52) | 0.0004 |
| Total Kjeldahl Nitrogen (mg/L) | 1.76 | 1.77 | 1.47 | 18 (27) | 1.77 | 36 (52) | 1.44 |
| Orthophosphate as P (mg/L) | 0.012 | 0.004 | 0.008 | 18 (27) | 0.017 | 34 (50) | 0.005 |
| Total Iron (µg/L) | 227 | 119 | 102 | 2 (4) | 313 | 6 (8) | 106 |
| Silica (mg/L) | 7.95 | 9.58 | 7.83 | 2 (4) | 9.38 | 6 (8) | 9.20 |
| Sulfate (mg/L) | 27.4 | 21.6 | 27.9 | 2 (4) | 29.4 | 6 (8) | 25.7 |
| Alkalinity (mg/L) | 273.3 | 220.7 | 216.8 | 2 (4) | 281.0 | 6 (8) | 237.9 |
| Dissolved Chloride (mg/L) | 82.2 | 81.6 | 74.9 | 2 (4) | 78.3 | 6 (8) | 71.1 |
| Dissolved Sodium (mg/L) | 57.1 | 55.9 | 50.4 | 2 (4) | 55.6 | 6 (8) | 48.6 |
| Dissolved Potassium (mg/L) | 4.1 | 5.3 | 4.9 | 2 (4) | 3.8 | 6 (8) | 4.8 |
| Dissolved Calcium (mg/L) | 107.6 | 83.9 | 84.7 | 2 (4) | 109.8 | 6 (8) | 91.8 |
| Dissolved Magnesium (mg/L) | 8.8 | 8.2 | 7.4 | 2 (4) | 9.3 | 6 (8) | 7.8 |
| Ametryn (µg/L) | 0.051 | 0.061 | 0.062 | 4 (4) | 0.050 | 6 (8) | 0.055 |
| Atrazin (µg/L) | 0.815 | 0.413 | 0.415 | 4 (4) | 0.994 | 6 (8) | 0.627 |

-NA- : Not Applicable
n: number of samples with flow (total number of samples)

**Table 4A-13** lists the herbicides that were analyzed in surface waters from STA-6. The four-quarter average outflow concentration for all compounds was lower than or equal to corresponding inflow concentrations. Although not a permit requirement, it is important to note that during each quarter, herbicide concentrations at the outflow were less than at the inflow. The herbicides detected are not used for vegetation management at STA-6, but are typical of areas with nearby intensive agricultural activity.

The District has included the following documentation to satisfy the remaining monitoring requirements of the EFA permit:

- The District has performed all sampling and analysis under the latest FDEP-approved CompQAP No. 870166G (June 1999).
- A signed copy of this statement prepared by Maxine Cheesman, director of the Water Quality Monitoring Department, Division of Environmental Monitoring and Assessment, SFWMD, the individual responsible for implementation of the sampling program during this period is provided in **Appendix 4A-2**.

## Mercury

The results of mercury compliance monitoring for routine operation are summarized in **Appendix 4A-4** of this chapter. During Water Year 2002 there were no violations of the Florida Class III numerical water quality standard of 12 ng/L unfiltered total mercury (THg). As such, the Everglades Construction Project has met one of the requirements of the operating permits.

After four years of operation, STA-6 continued to exhibit fluctuations in Hg species in water and Hg levels in resident fish. Following a drydown and re-wetting event during the second quarter of 2001, concentrations of THg and MeHg in the unfiltered surface water spiked at STA-6 outflows, reaching 7.0 ng THg /L and 3.4 ng MeHg/L. While a scoping-level assessment found THg loads out of STA-6 to be similar to or less than inflow loads (including atmospheric deposition), loads of MeHg out of the STA were found to exceed inflow loads by approximately 2-7 grams. A more intensive follow-up study is planned to more accurately quantify MeHg mass loading and export on an annual average basis. Resident fishes continued to exhibit a positive percent change in Hg across STA-6; however, there was no evidence that the spike in water column MeHg was followed by significant increases in mercury bioaccumulation over background. While levels of Hg in STA-6 fishes have fluctuated near background and are similar to or lower than levels found in other areas of the Everglades, there is some risk of adverse chronic effects from mercury exposure to fish-eating wildlife based on USFWS and USEPA criteria if feeding preferentially at STA-6. For perspective, the entire Everglades still remains under Department of Health advisories, recommending no or limited consumption of select fish species due to high mercury levels in their flesh

Another event of anomolously high mercury levels occurred in STA-6 in June 2002 during the initial rewetting following the extended seasonal dry out of the STA. This was reported to the FDEP in July 2002 following quality assurance confirmation. This event will be reported in detail in next year's report.